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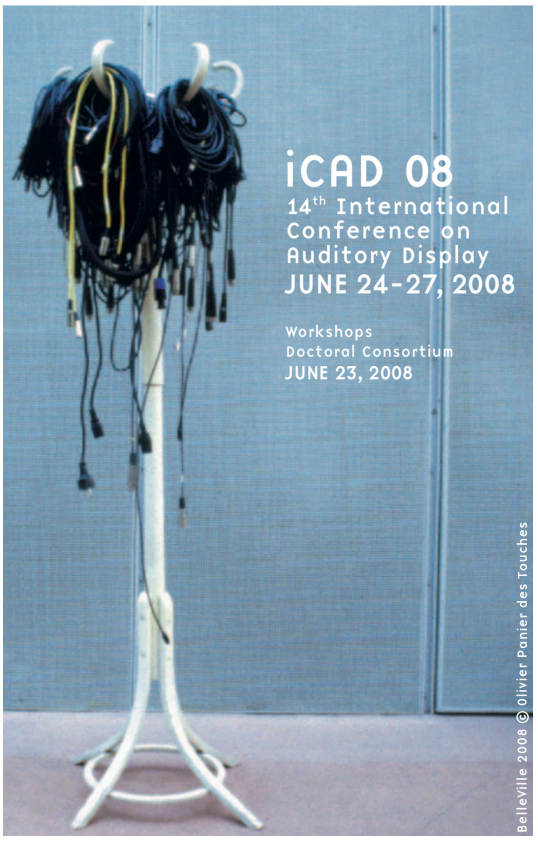
http://icad08.ircam.fr



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ICAD International Community for Auditory Display

http://www.icad.org

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Contents

INTRODUCTION

IRCAM is dedicated to renewing the relationships between contemporary music creation and multidisciplinary research on music and sound, with applications in all fields of sound technologies.

Many of its research projects are related to current issues of the ICAD community: tools and methodologies for sound design (e.g. as part of the European CLOSED project), spatial audio in the context of multimodal virtual reality (CROSSMOD, CORSAIRE, EARTOY projects), sound interaction (SID, i-MAESTRO, SAME projects), sound synthesis and processing tools (AudioSculpt and Modalys software environments), etc.

It is hoped that this hosting of ICAD in the broadly multidisciplinary framework of Science and Technology of Music and Sound (IRCAM-STMS), with a special emphasis on software tools for sound composition and design, will foster stimulating exchanges.

Hugues Vinet, Scientific Director, IRCAM

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KEYNOTES

Embodied music cognition, is it relevant to sound design?

Marc Leman

Abstract In embodied music cognition experiments, the subject is given an active role as explorer of the musical world, rather than being a passive registrator of musical stimuli. Attention is thereby focused on the subject's action-oriented ontology (body schema/ image), which allows anticipation and motor simulation of intended actions. In this talk, I will introduce the main concepts of embodied music perception and compare its particular semantic nature with the assumed causal nature of everyday sound perception. I will argue that the human body can be conceived as the natural mediator, which allows a transformation from proximal cues of the stimulus to its distal meaning, or, from physical characteristics to experiences. Embodiment may be of particular interest to sound design efforts that go beyond the notion of causal semantics, such as affordance, intended action and corporeal-based sound interaction.

Reference: M. Leman (2008) Embodied Music Cognition and Mediation Technology. Cambridge, MA: MIT Press.

From Computer Assisted Composition to Live Interaction with Musical Content

Gérard Assayag

Abstract Computer assisted composition have been around for a few decades and powerful tools have been designed. By connecting these rule-level, off-line tools to the proper interaction devices, and by reducing raw signal data to symbolic-level lexical units one can now envision new types of musical interaction involving cognitive models of memory and learning.
Applications extend from improvized live interaction to open-form composition, deconstruction and reconstruction of existing music, musical clone or augmented instruments.

SESSION : Sound Design Tools

Time-domain analysis / synthesis of the excitation signal in a source/filter model of contact sounds

Mathieu Lagrange, Gary Scavone and Philippe Depalle

Abstract Contact sounds represent an important subset of environmental sounds that are useful for enhancing the interaction of a user with a computer-simulated virtual reality or augmented environment. The real-time synthesis of these sounds has received much attention in the auditory display community and some convincing results have been achieved. This paper focuses on the modeling, analysis, and synthesis of more complex contact interactions, such as sliding, rolling and bouncing. We assume the widely adopted source-filter approach and use a modal representation of the filter component. In this paper, an explicit time-domain model of the excitation is proposed that produces promising results. The main advantages of the proposed model is that it allows a compact and versatile representation of the system, as well as an efficient synthesis scheme.

[pdf version]

AudioPlusWidgets: Bringing Sound to Software Widgets and Interface Components

Benjamin K. Davison and Bruce N. Walker

Abstract Using sound as part of the user interface in a typical software application is still extremely rare, despite the technical capabilities of computers to support such usage. The ICAD community has developed several interface concepts, patterns, and toolkits, and yet the overall software scene has remained dominated by the visual-only user interface. AudioPlusWidgets is a software library offering scientifically grounded audio enhancements to the standard Java Swing API. Through metaphors and transparency, AudioPlusWidgets can be inserted into existing code with minimal changes, easily adding auditory capabilities to the interface components in the system. This library uses an event-based model and an audio manager to render speech, MIDI, and prerecorded sounds.

[pdf version]

Visualising the soundfield and sounscape: extending MacCaulay and Crerar's 1998 method

Iain McGregor, Alison Crerar, David Benyon and Grégory Leplâtre

Abstract The introduction of effective auditory warnings into a shared environment requires a prior understanding of the existing soundfield and soundscape. Reifying the physical and perceptual auditory environment enables a form of pre auditioning, as well as the evaluation of any auditory augmentation. This paper describes the development of a visualisation technique for soundscape mapping. Building on earlier published work in sound classification, we report data captured using eighteen participants in a shared office environment. The resulting sound classification is used as the basis of a pictorial soundscape and soundfield visualisation. We show how this representation can be used to model the experiences of individuals, as well as subsets of users of the space.

[pdf version]

SESSION: Interaction

The effect of spatialization in a data sonification exploration task

Brian FG Katz, Emmanuel Rio, Lorenzo Picinali and Olivier Warusfel

Abstract This study presents an exploration task using interactive sonification to compare different sonification mapping concepts. Based on the real application of protein-protein docking within the CoRSAIRe project (« Combinaisons de Rendus Sensori-moteurs pour l'Analyse Immersive de Résultats », or Combination of sensori-motor rendering for the immersive analysis of results), an abstraction of the task was developed which simulates the basic concepts involved. Two conditions were evaluated, the inclusion or absence of spatialized coherent rendering of the sonification output. The position of the sonification was determined by the user's orientation sensor used for the exploration task. Results showed no significant benefit in the spatialized condition, and for some examples the non-spatialized condition resulted in better performance. This test is the first in a series of studies using this test platform.

[pdf version]

Could function-specific prosodic cues be used as a basis for non-speech user interface sound design ?

Kai Tuuri and Tuomas Eerola

Abstract It is widely accepted that the nonverbal parts of vocal expression perform very important functions in vocal communication. Certain acoustic qualities in a vocal utterance can effectively communicate one's emotions and intentions to another person. This study examines the possibilities of using such prosodic qualities of vocal expressions (in human interaction) in order to design effective non-speech user interface sounds. In an empirical setting, utterances with four context-situated communicative functions were gathered from 20 participants. Time series of fundamental frequency (F0) and intensity were extracted from the utterances and analysed statistically. Results show that individual communicative functions have distinct prosodic characteristics in respect of pitch contour and intensity. This implies that function-specific prosodic cues can be imitated in the design of communicative interface sounds for the corresponding functions in human-computer interaction.

[pdf version]

- Figure 2: [utterance-slow.wav] [synthetic-slow.wav] [utterance-urge.wav] [synthetic-urge.wav] [utterance-ok.wav] [synthetic-ok.wav] [utterance-reward.wav] [synthetic-reward.wav]
- Table 3: [beeper-slow.wav] [beeper-urge.wav] [beeper-ok.wav] [beeper-reward.wav]

Kernel regression mapping for vocal EEG sonification

Thomas Hermann, Gerold Baier, Stephani Ulrich and Helge Ritter

Abstract This paper introduces kernel regression mapping sonifica- tion (KRMS) for optimized mappings between data features and the parameter space of Parameter Mapping Sonification. Kernel regression allows to map data spaces to high dimensional parameter spaces such that specific locations in data space with predetermined extent are represented by selected acoustic parameter vectors. Thereby, specifically chosen correlated settings of parameters may be selected to create perceptual fingerprints, such as a particular timbre or vowel. With KRMS, the perceptual fingerprints become clearly audible and separable. Furthermore, kernel regression defines meaningful interpolations for any point in between. We present and discuss the basic approach exemplified by our previously introduced vocal EEG sonification, report new sonifications and generalize the approach towards automatic parameter mapping generators using unsupervised learning approaches.

[pdf version]

SESSION: 3D Audio - Perception

Influence of performance gestures on the identification of spatial sound trajectories in a concert hall

Georgios Marentakis, Joe Malloch, Nils Peters, Mark Marshall, Marcelo Wanderlay and Stephen McAdams

Abstract An experimental study was performed on the effects of the visibility of a performer's gestures on the identification of virtual sound trajectories in the concert hall. We found that when working in synchrony, the performer's gestures integrate with the audio cues to significantly increase identification performance, normalize for the effects of off-centre listening in the hall and overcome problems related to the complexity of the soundscape. In the absence of visual cues, identification performance depends on the listening seat, the sound trajectory and the complexity of the soundscape.

[pdf version]

Effects of temporal fine structure on the localization of broadband sounds: potential implications for the design of spatial audio displays

Douglas S. Brungart and Brian D. Simpson

Abstract In the design of symbology for spatial audio displays, a great deal of emphasis has been placed on the importance of bandwidth for achieving robust localization accuracy. However, there are some cases where the temporal characteristics of a audio signal can have a large impact on its localizability. In this study, we examined localization accuracy for three different wideband stimuli: a broadband noise, a 100-Hz click train, and a 100-Hz click train with randomized phase. When the stimulus presentation level was low (40 dB SPL), localization performance was reasonably good for all three stimuli. However, as the presentation level increased to 70 dB or higher, localization performance degraded dramatically for the click train stimulus but remained roughly constant for the other two stimuli. The results suggest that display designers must consider some factors other than bandwidth when they design the symbology for real-world spatial audio displays.

[pdf version]

Individualization feature of head-related transfer functions based on subjective evaluation

Satoshi Yairi, Yukio Iwaya and Yôiti Suzuki

Abstract To realize a three-dimensional virtual sound image with a Virtual Auditory Display (VAD), it is important to individualize Head Related Transfer Functions (HRTFs) for listeners. The purpose of the present study was to establish a fitting method for HRTFs based on a listening test. To this end, a number of sets of virtual images were synthesized using HRTFs of different individuals. The listeners were then asked to choose appropriate virtual sound images located in the intended orbits. To achieve our fitting method of HRTFs by such a subjective evaluation, it is desirable that the same HRTFs can be chosen with stability. In this study, the process used to select a set of HRTFs subjectively was examined in detail, and the features of the individualization of HRTFs by subjective evaluation were investigated. First of all, the process to choose the best of 32 sets of HRTFs by a Swiss-style tournament was repeated ten times, and the regularity of wins in the tournament was examined. As a result, it was understood that the same set of HRTFs is not always chosen and that the individualization method has probability features. The strength of the sets of HRTFs which won the tour- nament several times was then evaluated. A round-robin comparison with the 130 sets of HRTFs in our HRTF-corpus was repeated twenty times. It was shown that a subjective evaluation itself was also a probability feature. Moreover, the percentage of winning for the set of HRTFs which won the tournament was estimated to be about 15% from the results of the round-robin comparison.

[pdf version]

A study toward the development of a spatial, non-speech auditory interface for trigonometric problem solving

Flaithrí Neff and Ian Pitt

Abstract There are numerous difficulties for visually disabled students when tackling mathematical problems. This relates more to methods of presentation rather than to any deficiency in the students' abilities. Although presentational advances have been made in some instances, such as for algebraic equations, problems remain when attempting to convey inherently spatial mathematics such as trigonometry or matrices. The linearity of speech and Braille output is not easily mapped to spatial attributes and therefore other methods may prove more useful in this regard. We suggest the use of non-speech spatial sound to convey an overview of trigonometric shapes. Our aim is to provide a rapid overview without relaying specific information such as angle degrees or side lengths. Later we plan to use speech and virtual navigation to enable the user to extract precise information if required while retaining the ability to revert to an overview at any stage. Our current concern is how to relay a relatively accurate picture of a trigonometric shape to the blind student using non- speech spatial audio. We therefore examine various non-speech methods of notifying the user to the presence of an angle. We compare various methods for time efficiency and accuracy. We use Microsoft XNA/XACT technology to render the non- speech, spatial sound streams and employ a User Interface Model to consider the psychoacoustic elements involved.

[pdf version]

Evaluating listeners' attention to and comprehension of spatialized concurrent and serial talkers at normal and a synthetically faster rate of speech

Derek Brock and Brian McClimens and J. Gregory Trafton and Malcolm McCurry and Dennis Perzanowski

Abstract Concurrent voice communications workload has been identified as a pivotal issue for desired reductions in the size of Navy watchstanding teams on future platforms. Without effective augmenting technologies, real increases in current per-person communications monitoring requirements will lead to unacceptable reductions in operator performance. A proposal to buffer voice communications and monitor them serially at synthetically increased rates of speech has recently been put forward as an alternative to concurrent monitoring. However, any decrements in listening performance associated with temporal scaling must be weighed against the costs of current practices. A comparative study reported here examines measures of auditory attention and comprehension in different multitalker contexts using long blocks of continuous speech. In four conditions, listeners respectively heard two and four concurrent talkers and four serial talkers (i.e., one at a time) speaking normally and 75% faster. With only a few exceptions, all pairwise differences between measures were significant. Performance in the faster serial condition was lower than in the normal serial condition, but was found to be greater than in either of the concurrent conditions by a substantial margin.

[pdf version]

▶ [O_46-1.wav] [O_46-2.wav] [O_46-3.wav] [O_46-4.wav]

SESSION: Browsing Sound

Encoding and representation of information in auditory graphs: descriptive reports of listener strategies for understanding data

Michael A. Nees and Bruce N. Walker

Abstract While a growing wealth of data have offered insights into the best practices for auditory display design and application, little is known about how listeners internally represent and use the information presented in auditory displays. At the conclusion of three separate studies, participants responded to an open-ended question about the strategies they used to perform auditory graphing tasks. We report a descriptive analysis of these qualitative responses. Participants' comments were coded by two raters along a number of dimensions that were chosen to represent a comprehensive set of encoding and task strategy possibilities. These descriptive analyses suggest that auditory graph listeners use a variety of strategies to cognitively represent the data in the display. Furthermore, these qualitative data offer a number of insights and questions for future research on information representation for auditory displays.

[pdf version]

Scalable Auditory Data Signatures for Discovery Oriented Browsing in an Expressive Context

Joachim Gossmann and Ruth West

Abstract To be useful for browsing in vast multidimensional databases, auditory representations need to be able to scale in depth and detail. The concepts of quantitative and qualitative listening are presented and Scalable Auditory Data Signatures introduced conceptually. The implementation of these concepts within the interdisciplinary project "ATLAS in silico" is described.

[pdf version]

Efficiency of spearcon-enhanced navigation of one dimensional electronic menus

Dianne K. Palladino and Bruce N. Walker

Abstract This study investigated navigation through a cell phone menu in the presence of auditory cues (text-to-speech and spearcons), visual cues, or both. A total of 127 undergraduates navigated through a 50-item alphabetically listed menu to find a target name. Participants using visual cues (either alone or combined with auditory cues) responded faster than those using only auditory cues. Performance was not found to be significantly different among the two auditory only conditions. Although not significant, when combined with visual cues, spearcons improved navigational efficiency more than both text-to- speech cues and menus using no sound, and provided evidence for the ability of sound to enhance visual menus. Research results provide evidence applicable to efficient auditory menu creation.

[pdf version]

SESSION: Applications

SUMO. A sonification utility for molecules

Florian Grond and Fabio Dall'Antonia

Abstract In this paper we present SUMO, an open source software environment, which is designed to facilitate the open development of molecular sonifications for everyday research in chemistry and structural biology. Sonifications of chemical data are developed since more than 25 years but surprisingly auditory display is not yet a scientifically established mode to interact and explore molecular data. Before presenting SUMO we introduce the implications of presenting molecular data to the sonification community. For chemists and structural biologists, we briefly review different sonification approaches made so far and discus their potential. Within this broader scope we situate SUMO, the lab proof sonification framework. We describe the software environment in detail and present two implementations of methods for sonifying conformations of amino acids and B factors.

[pdf version]
http://sonification.kommerz.at/chemie/sonifications.html

/ .mp3
- Prototype sonifications of amino acids: [proline] [glutamic acids] [alanin] [valin] [glutamin] [arginine] [tyrosin]
- Sonifications of various B-factor distributions in Proteins: [1] [2] [3] [4]

SONIFYER. A concept, a software, a platform

Florian Dombois, Oliver Brodwolf, Oliver Friedli, Iris Rennert and Thomas Koenig

Abstract In this article we would like to focus on two structural points that could be useful for improving the general acceptance of sonification research: On the one hand we will be advocating a new generation of sonification software that can be easily and intuitively used by researchers and amateurs alike. On the other hand we will argue for an acoustic forum for our sonification community to be established that will help to faster exchange and discuss listenable research results. For both aspects we will describe our ideas and prototypes as a possible starting ground for discussion.

[pdf version]

Pairing colored socks and following a red serpentine with sounds of musical instruments

Guido Bologna, Benoît Deville and Thierry Pun

Abstract The See ColOr interface transforms a small portion of a colored video image into sound sources represented by spatialized musical instruments. This interface aims at providing visually impaired people with a capability of perception of the environment. As a first step of this on-going project, the purpose is to verify the hypothesis that it is possible to use sounds from musical instruments to replace color. Compared to state of the art devices, a quality of the See ColOr interface is that it allows the user to receive a feed-back auditory signal from the environment and its colors, promptly. Two experiments based on a head mounted camera have been performed. The first experiment pertaining to object manipulation is based on the pairing of colored socks, while the second experiment is related to outdoor navigation with the goal of following a colored serpentine. The "socks" experiment demonstrated that seven blindfolded individuals were able to accurately match pairs of colored socks. The same participants successfully followed a red serpentine for more than 80 meters.

[pdf version]

- [seeColOr.avi]
- [flash video (browser)]

SESSION: Auditory Display

Database concept for medical auditory alarms

Max Schneider

Abstract With this paper we want to explore the benefits of an online available database for medical functional sounds and auditory alarms. The concept is inspired by an extensive context research in the medical field and aims to evoke discussion and trigger possible corporations in the future. The database so far exists as a concept design and aims to be realized as a research project in university using funds form the EXIST program and other interested research institutions as well as hospitals. The database is conceived to be a WIKI based platform, content will be supplied by manufacturers, hospitals and designers, nevertheless aims are to supply an initial baseline of medical device sound sets to show functionality and benefits for the users in the hospital and company context can draw from it. The paper will introduce basic elements of the database, a brief summary of the current situation and outlook on the possibilities when incorporating the database into a design process.

[pdf version]

Ambience for auditory displays: embedded musical instruments as peripheral audio cues

Ralf Jung

Abstract From alarm signals and data sonification to multimodal interfaces, auditory displays are omnipresent in our everyday life and they become more and more popular. But there are some challenges we have to meet because of the differentness of the auditory sense compared to the visual sense. Usually, audio notification signals are limited to simple warning cues and system feedback that are in most cases intrusive be- cause they differ from the environmental noise. That has the effect that people present in the room could be distracted from their current tasks because they cannot "close their ears." To prevent the disturbing effect of traditional notification signals we developed the novel concept of non-speech audio notification embedded in ambient soundscapes to provide multi-user notification in a more discreet and non-disturbing way. Instead of using well-known non-speech cues like auditory icons and earcons, we decided to compose and record peripheral soundscapes and notification instruments by ourselves towards a more aesthetic approach. In this paper, we give an overview of our location-aware system with two applications (PAAN, AeMN) and sketch a real life scenario in a wine department of a supermarket. We will also present findings from a user study and provide a small collection of notification instruments and soundscapes as audio samples.

[pdf version]

▶ [AS01Soundscape.mp3] [AS01Piano1.mp3] [AS01Piano2.mp3] [AS01HiHat.mp3] [AS01SoundscapeP+H.mp3]

Usability of non-speech sounds in user interfaces

Rafa Absar and Catherine Guastavino

Abstract We review the literature on the integration of non-speech sounds to visual interfaces and applications from a usability perspective and subsequently recommend which auditory feedback types serve to enhance human interaction with computers by conveying useful and comprehensible information. We present an overview over varied tasks, functions and environments with a view to establishing the best practices for introducing non-speech sounds in order to improve the overall experience of users.

[pdf version]

Learnability of sound cues for environmental features: auditory icons, earcons, spearcons and speech

Tilman Dingler, Jeffrey Lindsay and Bruce N. Walker

Abstract Awareness of features in our environment is essential for many daily activities. While often awareness of such features comes from vision, this modality is sometimes unavailable or undesirable. In these instances, auditory cues can be an excellent method of representing environmental features. The study reported here investigated the learnability of well known (auditory icons, earcons, and speech) and more novel (spearcons, earcon-icon hybrids, and sized hybrids) sonification techniques for representing common environmental features. Spearcons, which are speech stimuli that have been greatly sped up, were found to be as learnable as speech, while earcons unsurprisingly were much more difficult to learn. Practical implications are discussed.

[pdf version]

Cross cultural study of auditory warnings

Sabine Langlois, Clara Suied, Thierry Lageat and Aude Charbonneau

Abstract Auditory human machine interfaces (HMI) are used in cars to provide the driver with information. For security reasons, sound design should respect information urgency scaling. In view of a continuous increase of Renault's sales worldwide, getting a better understanding of urgency perception of sounds is fundamental. Scientific knowledge is not very widespread about possible cross-cultural differences for auditory alarms, but seems to indicate that people from different countries would agree more on urgency perception of abstract sounds than environmental sounds. The aim of this study is to specify which acoustical parameters influence urgency perception of sounds, worldwide., A experiment was conducted in six countries, representative of Renault's customers: France, Germany, Great Britain, Turkey, Korea and the USA. Sixteen sounds were designed according to different acoustical parameters (frequency, timbre and onset of the pulses), and split into two sets depending on their tempo: one set at a fast tempo, one at a slower tempo. The results are very similar in the six countries. The auditory HMI are perceived as urgent when the frequency is high, at both tempi. At a fast tempo, a short attack time increases urgency perception. Abstract auditory HMI following frequency and onset guidelines should be perceived worldwide similarly along an urgency scale. These recommendations have been applied to design auditory HMI to be sounded by the instrument panel of vehicles recently released.

[pdf version]

▶ [slow tempo.ppt / pc] [fast tempo.ppt / pc]

SESSION: 3D Audio - Technologies

Three-dimensional sound field reproduction and recording systems based on boundary surface control principle

Seigo Enomoto, Yusuke Ikeda, Shiro Ise and Satoshi Nakamura

Abstract Based on the boundary surface control (BSC) principle, a new recording/reproduction system is developed to realize high fidelity three-dimensional sound field reproduction. Theoretically, using this new system, perfect sound field reproduction can be achieved in any acoustic environment. Sound recording / reproduction systems based on the BSC principle require many loudspeakers and microphones. In the new system, the microphone array system that is used to record the 3D sound field consists of 70 microphones, and the loudspeaker system to reproduce the recorded 3D sound field consists of 62 full-range units and eight sub-woofer units. This paper describes the composition of the new recording / reproduction system and evaluates its ability by means of sound localization tests with nine subjects. Results of experiments show that a clear sound image in the horizontal plane is reconstructed using the proposed system.

[pdf version]

Spherical microphone array based immersive audio scene rendering

Adam M. O'Donovan, Dmitry N. Zotkin and Ramani Duraiswami

Abstract In many applications such as entertainment, education, military training, remote telepresence, surveillance, etc. it is necessary to capture an acoustic field and present it to listeners with a goal of creating the same acoustic perception for them as if they were actually present at the scene. Currently, there is much interest in the use of spherical microphone arrays for acoustic scene capture and reproduction. We describe a 32-microphone spherical array based system implemented for spatial audio capture and reproduction. Our array embeds hardware that is traditionally external, such as preamplifiers, filters, digital-to-analog converters, and USB adaptor, resulting in a portable lightweight solution and requiring no hardware on the PC side whatsoever other than a high-speed USB port. We provide capability analysis of the array and describe software suite developed for the application.

[pdf version]

Design, validation and in-flight evaluation of an auditory attitude indicator based on pilot-selected music

Douglas S. Brungart and Brian D. Simpson

Abstract Although all cockpits are currently equipped with visual displays that provide accurate information about the attitude of the aircraft, spatial disorientation continues to be one of the leading causes of aviation accidents. In this paper, we describe the design of an audio display that modifies the acoustic properties of an arbtrary audio input signal (i.e., pilot-selected music) to provide the pilot with supplementary information about the current attitude of the aircraft. Details are provided about how and why the cues were selected, and how they were implemented in a real-time audio system in the aircraft. Results are also provided from laboratory and flight tests that were used to evaluate the performance of the system.

[pdf version]

SESSION: Sonification

Exploration of 4D-data spaces. Sonification in lattice QCD

Katharina Vogt, Till Bovermann, Philipp Huber and Alberto de Campo

Abstract We describe a pilot study on the sonification of data from lattice Quantum Chromodynamics, a branch of computational physics. This data is basically 4-dimensional and discretized on a lattice. The implementation allows interactive navigation through the data via different interfaces. Two different sonification schemes have been applied, giving information on small regions of the lattice. In real data sets we searched for structures that are hidden by quantum fluctuations. First results have been achieved with simplified data sets.

[pdf version]

http://sonenvir.at/data/lattice/sounds/

/ .mp3

▶ [DynRes-Paus-0.1sec] [DynRes-Paus-0.5sec] [DynRes-Paus-0.25sec]

▶ [ResAudif-Paus-0.1sec] [ResAudif-Paus-0.5sec]

▶ [SmearedDataNoStruct] [SmearedDataStruct]

Exploratory sound analysis: sonifying data about sound

Sam Ferguson and Densil Cabrera

Abstract Sound is commonly analysed subjectively by listening to it. However, when we want to analyse a sound objectively, we often switch domains, and change to visual or numerical displays. While it is likely that, generally speaking, the visual sense dominates other senses, when the data being explored are sound the question naturally arises as to whether these data may be statistically represented in that same domain. This paper describes and demonstrates a general scheme for building statistical representations of sound that exist entirely within the auditory domain, and use the original audio data to present descriptive data.

[pdf version]

Sonification of directional and emotional content: Description of design challenges

Antti Pirhonen and Henni Palomäki

Abstract In the construction of sound objects into an application, the designer's skills to communicate through sounds is the cornerstone of the activity. In such an expertise, the knowledge about the human way of interpreting different properties of sounds is essential. This paper is a description of two experiments, in which the semantics of tempo change, pitch change and intensity change of sound has been studied by asking the participants of the experiments to combine sounds to visual images. The images in the first experiment were photos which had been validated in terms of their emotional content. In the second experiment, the images were arrows pointing in various directions. The results show that studying context independent semantics of non-speech sounds with the help of photos is problematic, but some tendencies can be revealed. On the other hand, simple information units like physical directions, can be illustrated with changes in intensity and tempo, but especially with change in pitch.

[pdf version]

▶ [s0.wav] [s10.wav] [s20.wav] [s30.wav] [s40.wav] [s50.wav] [s60.wav] [s70.wav]

A review-based conceptual analysis of auditory signs and their design

Manne-Sakari Mustonen

Abstract The research frames of auditory display have traditionally mainly focused on the evaluation of different applications and devices, whereas the theoretical development has had a minor role. In order to reach the goal of functional and intuitive auditory signs, the theoretical basis must be on a robust basis. User interface sound types have been traditionally divided into two exclusionary sound types: earcons and auditory icons. However, when approaching the issues from the viewpoints of for example human communication or semiotics, one can see that the current definitions and practices in auditory display as a scientific discipline are not pragmatic. It is recommended to define auditory signs to include different levels of meaning, as was originally proposed. Following current theoretical concepts leaves the full potential of auditory signs unexposed. In this paper, I introduce important viewpoints and approaches for more practical theoretical approaches for the design of auditory signs in order to develop a theoretical basis for usable syntax.

[pdf version]

SESSION: Psychology

The effect of Music on Learning in Virtual Environments - Initial Results

Eric Fassbender, Debbie Richards, Bill Thompson, Ayse Bilgin and Alan Taylor

Abstract In this paper we discuss the effect of music on learning in virtual-immersive environments. Auditory stimuli were presented within a specialized display system in which seventy- two undergraduate students watched a 3-D computer animated video. This video included narrated historical information and background music. Background music was experimentally manipulated to create six versions of the video: No Music; original tempo/pitch; fast-tempo music; slow-tempo music; low-pitched music; and high-pitched music. After watching the video, participants were tested on the historical material presented, and answered a number of other questions about the video and background music. Data analyses revealed that people under the influence of one particular computer game soundtrack remembered information better than their peers at statistically significant level. Also, those participants who were more immersed into the virtual environment performed significantly better. Further encouraging results are reported in this paper, however, follow-up experiments are needed.

[pdf version]

Perceived self motion in virtual acoustic space facilitated by passive whole-body movement

William L. Martens, Shuichi Sakamoto and Yôiti Suzuki

Abstract When moving sound sources are displayed for a listener in a manner that is consistent with the motion of a listener through an environment populated by stationary sound sources, listeners may perceive that the sources are moving relative to a fixed listening position, rather than experiencing their own self motion (i.e., a change in their listening position). Here, the likelihood of auditory cues producing such self motion (aka auditory-induced vection) can be greatly facilitated by coordinated passive movement of a listener's whole body, which can be achieved when listeners are positioned upon a multi-axis motion platform that is controlled in synchrony with a spatial auditory display. In this study, the temporal synchrony between passive whole-body motion and auditory spatial information was investigated via a multimodal time-order judgment task. For the spatial trajectories taken by sound sources presented here, the observed interaction between passive whole-body motion and sound source motion clearly depended upon the peak velocity reached by the moving sound sources. The results suggest that sensory integration of auditory motion cues with whole-body movement cues can occur over an increasing range of intermodal delays as virtual sound sources are moved increasingly slowly through the space near a listener's position. Furthermore, for the coordinated motion presented in the current study, asynchrony was relatively easy for listeners to tolerate when the peak in whole-body motion occurred earlier in time than the peak in virtual sound source velocity, but quickly grew to be intolerable when the peak in whole-body motion occurred after sound sources reached their peak velocities.

[pdf version]

Affective multimodal displays: acoustic spectra modulates perception of auditory-tactile signals

Ana Tajadura-Jiménez, Aleksander Väljamäe, Norimichi Kitagawa and Daniel Västfjäll

Abstract Emotional events may interrupt ongoing cognitive processes and automatically grab attention, modulating the subsequent perceptual processes. Hence, emotional eliciting stimuli might effectively be used in warning applications, where a fast and accurate response from users is required. In addition, conveying information through an optimum multisensory combination can lead to a further enhancement of user responses. In the present study we investigated the emotional response to sounds differing in their acoustic spectra, and their influence on speeded detection of auditory-somatosensory stimuli. Higher sound frequencies resulted in an increase in emotional arousal. We suggest that emotional processes might be responsible for the different auditory-somatosensory integration patterns observed for low and high frequency sounds. The presented results might have important implications for the design of auditory and multisensory warning interfaces.

[pdf version]

/ .wav

- [f1 (100-400 Hz] [f2 (920-1480 Hz] [f3 (2700-4400 Hz] [f4 (9500-23000 Hz]
- [low (frequency band 100-920 Hz)] [high (frequency band 14000-17000 Hz)]

SESSION: Design Theory

Stream-based sonification diagrams

Stephen Barrass and Virginia Best

Abstract The van Noorden Diagram describes the auditory streaming of two tones with changes in pitch difference and intertone onset interval (IOI). There are regions where the listener hears one stream or two streams, and an ambiguous region between where listening attention affects what is heard. The ambiguous region dominates at IOI ¿ 200ms which is where many sonifications are designed. We propose a Stream-Based Sonification region at IOI ¡ 200ms to control streaming and reduce the ambiguous effects of attention. In this paper we generalise this region in a series of four Stream-Based Sonification Diagrams. The first is a repetition of the original van Noorden Diagram at higher temporal resolution in the SBS region. The other three show the same general pattern of regions for new mappings of the brightness, amplitude and pan of a noise. The results show that streaming by brightness and pitch are closely related. They also show a new coherence boundary for streaming by amplitude, and that streaming by spatial panning is relatively unaffected by IOI. The palette of Stream-Based Sonification Diagrams developed here provides a foundation for the design of sonifications that control streaming and take listening attention into account.

[pdf version]

Auditory stimulus design: musically informed

K. Stallmann, S.C. Peres and P. Kortum

Abstract This paper discusses an approach to auditory stimulus design that appropriates concepts and techniques commonly used in music composition. These ideas are used to create referential sound cues that orient a listener along a timeline. The functions these cues serve may include: emphasizing arrival at targeted goals; providing orientation information relative to beginning and end times; or creating a sense of imminent closure indicating a predictive end to an ongoing process. The stimulus used in the pilot study represents this team's first attempt at integrating musical ideas with stimulus design. In an effort to make this stimulus comparable with previously used experimental stimuli, extreme restrictions were placed on the design. Although the resulting stimulus is not to be confused with 'music' in the proper sense of that term, it is interesting to note how an extremely restricted set of elements can be manipulated to create an aesthetically satisfactory experience that rivals responses to 'real' music in untrained listeners. The application of musical techniques towards the construction of effective auditory stimuli that are, at the same time, rated aesthetically satisfactory by users, is a long-term object of study by this team.

[pdf version]

Taxonomy and definitions for sonification and auditory display

Thomas Hermann

Abstract Sonification is still a relatively young research field and many terms such as sonification, auditory display, auralization, audification have been used without a precise definition. Recent developments such as the introduction of Model-Based Sonification, the establishment of interactive sonification and the increased interest in sonification from arts have raised the need to revisit the definitions in order to move towards a clearer terminology. This paper introduces a new definition for sonification and auditory display that emphasizes the necessary and sufficient conditions for organized sound to be called sonification. It furthermore suggests a taxonomy, and discusses the relation between visualization and sonification. A hierarchy of closed-loop interactions is furthermore introduced. This paper aims to initiate vivid discussion towards the establishment of a deeper theory of sonification and auditory display.

[pdf version]

SESSION: Sound Design (organized by SID and Closed projects)

Sonic Interaction Design http://www.cost-sid.org/
Closed http://closed.ircam.fr

The laughing swing: interacting with non-verbal human voice

Michal Rinott

Abstract This paper looks at non-speech uses of the human voice in interactive objects. A collection of projects using non-verbal voice, as input and as output, is briefly reviewed. The Laughing Swing - an interactive object using non-verbal voice as output, created by the author and associates - is described in terms of motivations, sound design, sonic behavior implementation and user responses. The significance and potential of interactions with non verbal voice is discussed.

[pdf version]

Sound design for navigation in topophonies

Roland Cahen

Abstract This paper attempts to develop concepts of multimodal objects made out of the interaction between space and sound though motion. The present paper is mostly descriptive and tries to gather experiences in order to delimit a new field of applications, concepts and method. My purpose is to describe some specificities of sound navigation design, starting from everyday life experience and cultural backgrounds towards virtual reality. My point of view will be that of a sound designer. I will examine different methods of implementation related to several sound navigation concepts and metaphors related to this particular approach. For this purpose, I will take different examples mainly in my works to show how some kind of scenarios propose different ways to link motion to sound, what kind of sound behaviours they produce, how they can be created and controlled, what kind of human and artistic experience they offer.

[pdf version]

- [Plumage.avi]
- [Piège à Rêve.avi]
- [PHASE.avi]
- [Les îles Marine.avi]
- [flash videos (browser)]

Strategies for sonic interaction design: from context to basic design

Karmen Franinovic and Yon Visell

Abstract We advocate a new approach to the design of interactive and sonically augmented artifacts. It is aimed at enriching the context within which design takes place, while integrating the level of structured exploration that has been instrumental to formalizing design processes for nearly a century. The proposed process combines the systematic approach of basic design with exploratory studies within an existing everyday setting. The approach is particularly salient for auditory display in products, due to the relative lack of design examples and methods that exist for those working in this area to draw upon. We describe a study undertaken in domestic kitchen, a setting that has long been recognized as ripe with expressive, sonic interactions. The results of this contextual research have been used for the design of sonically-augmented lamps. We analyze the relevant results, and describe plans for integrating assessment methods.

[pdf version]

Depthrow: A Physics-based Audio Game

Stefano Papetti, Delphine Devallez and Federico Fontana

Abstract We present an interactive audio game designed around the auditory perception of distance and the use of physics-based models for simulations of the dynamics, the sound source, and the acoustical environment. The game consists in throwing a virtual sound- ing object inside a virtual open-ended tube which is inclined. The task is to keep the object inside the tube, in other words the user should adjust the initial velocity applied to the object such that the latter does not fall out at the far end of the tube. The position of the object inside the tube is provided by continuous audio feedback. User performance is closely related to its ability to perceive the dynamic distance of the object in the virtual tube. Therefore, this game represents a potential tool for exploring the usability of auditory distance information in interaction design.

[pdf version]

POSTER

Internet-based interactive auditory virtual environment generators

Christian Borß, Andreas Silzle and Rainer Martin

Abstract In this paper we investigate general design considerations and practical implementation aspects for Internet-based interactive auditory virtual environments (I-AVE) for the post-PC era. An implementation of such an AVE generator as a web service allows for platform independent "AVE services" for mobile devices almost "anywhere on any device" using a standard web browser. We propose a client-server architecture which computes the acoustic sig- nals on a high-performance server and provides low-latency audio streaming from the server to the client.

[pdf version]

Sonification of bowing features for string instrument training

Oliver Larkin, Thijs Koerselman, Bee Ong and Kia Ng

Abstract This paper presents work on an auditory display for use in string instrument training, based on 3D motion analysis. We describe several sonifications that are intended to provide both real-time and non real-time feedback about bowing technique. Tests were conducted with string players to assess the effectiveness of the sonifications. We discuss our findings as well as ideas for further work in this area.

[pdf version]
http://www.i-maestro.org

Using web services to foster global collaboration in sound design

James A. Ballas and Justin Nevitt

Abstract The migration of client-server systems to web services using Service Oriented Architecture (SOA) design principles is widespread and likely to dominate the future evolution of computing. Use of web services is especially challenging for streaming content such as that which would be used for sound design. This paper describes the principles of a Service Oriented Architecture (SOA) and ways that it could support sound design and foster global collaboration across the web.

[pdf version]

Sonic explorations with earthquake data

Manuela Meier and Anna Saranti

Abstract The composition "underground sounds" - an interdisciplinary project including a concert piece as its artistic element - deals with the phenomenon of the constantly moving, therefore resonating earth and is based on data taken from an earthquake which reached 7.8 on the Richter scale and triggered a tsunami on April 1st, 2007 close to the Solomon Islands in the Southwestern Pacific. The data from several related seismic events was provided via a real-time data server belonging to the GEOFON network of seismic stations and converted to audio data using programs specifically developed for that purpose. "underground sounds" is not an audification; the seismometers records were used as raw material for several applications of signal processing effects. The four parts of the composition concentrate on different characteristics of seismic events including sounds of the same seismic event recorded by different stations, the filtered harmonic sounds of the measuring instruments and the output of the separation of the earthquake's impulse-like components from the earth's constant movements, each used as separate instruments in the composition.

[pdf version]

Manuela Meier: http://mm.mur.at/
Anna Saranti: http://www.quantumcomputerart.com/

Understanding aural fluency in auditory display design for ambient intelligent environments

Milena Droumeva and Ron Wakkary

Abstract This paper presents the design and some evaluation results from the auditory display model of an ambient intelligent game named socio-ec(h)o. socio-ec(h)o is played physically by a team of four, and displays information via a responsive environment of light and sound. Based on a study of 56 participants involving both qualitative and preliminary quantitative analysis, we present our findings to date as they relate to the auditory display model, future directions and implications. Based on our design and evaluation experience we begin building a theoretical understanding for the unique requirements of informative sonic displays in ambient intelligent and ubiquitous computing systems. We develop and discuss the emerging research concept of aural fluency in ambient intelligent settings.

[pdf version]

Evaluation of user habits for creating auditory representations of different software applications for blind persons

György Wersényi

Abstract Blind and visually disabled persons use special software environments – such as Windows-Eyes, JAWS, screen-readers, text-to-speech programs – to access personal computers. These software solutions may offer sound samples for a better orientation. Besides speech, there are auditory icons, earcons or spearcons as possible extension of visual information. Finding the optimal mapping between (visual) events on the screen and their auditory representation is a difficult task. In the frame of the GUIB (Graphical User Interface for Blind Persons) project we started a survey for blind persons as well as for users with normal vision to investigate their user habits and needs, in order to find the most important software applications and sub-functions. Questionnaires were filled in and evaluated to determine the most important and popular applications to be extended with sound representations in the future.

[pdf version]

Design of a sonar system for visually impaired humans

Cameron Morland and David Mountain

Abstract Constraints and features useful for an effective and easy to learn human sonar device are described. These include matching spatial cues generated by the device to those in the world. Techniques used by natural echolocators, including specifications of signal type, emitter, and receiver are briefly reviewed, as is techniques of converting ultrasonic signals to the audible range and techniques for externalizing sounds. Finally, a prototype sonar system designed while considering these ideas is described.

[pdf version]

Rhetorical schemes for audio communication

Pietro Polotti and Carlo Benzi

Abstract The application of rhetorical techniques to the use of non-verbal sound in the interaction between humans and technologies is the core idea of this paper. We present our ideas at a general level and illustrate an exploratory case based on the application of rhetorical schemes to the sonification of computer operating system events. Both cases of musical sounds and everyday sounds are investigated. This work is intended as a preliminary study aiming at motivating a larger scale and more rigorous research about the potentiality of the use of rhetoric in the domain of Auditory Display (AD) and Sonic Interaction Design (SID).

[pdf version]

/.wav

- [An anaphora figure is employed for composing an earcon that sonifies a "copy" OS function.]
- [The repetition is missing in the non-rhetorical counter-example.]
- [An epanalepsis figure is used for the sonification of an "undo" OS function.]
- [The repetition is missing in the non-rhetorical counter-example.]
- [An epizeuxis figure is adopted in order to stress an action that is recovered after being performed and then cancelled: a "redo" function.]
- [The repetition is missing in the non-rhetorical counter-example.]
- [The "copy" function is sonified by means of the "readymade" auditory icon provided by the paronomasia of Mickey's nose stung by the mosquito.]
- [The relation is missing in the non-rhetorical counter-example limited to the sole first sound.]
- [The motor-like sound of the mosquito attacking Horace Horsecollar realizes an auditory icon based on a wide-sense epanalepsis ("undo" function).]
- [The epanalepsis is missing in the non-rhetorical counter-example.]
- [The sound of the motor-mosquito produces an effect of wide-sense epizeuxis ("redo" function).]
- [The epizeuxis is missing in the non-rhetorical counter-example.]

Localization of virtual sound created using individualized and non-individualized HRTF for direct and reflected sound

Ryouichi Nishimura and Hiroaki Kato

Abstract Good sound localization is an essential factor required for virtual auditory display (VAD) systems. These systems especially those based on the Head-Related Transfer Function (HRTF) often encounter the problem where the locations of virtual sound images are perceived at different locations to those that have been assumed. Considering the fact that reflected sound enhances the reality of virtual space, the accuracy of sound localization in a VAD system might be improved by presenting not only direct but also reflected sound. Therefore, we investigated what effect the presence of a single reflected sound had on the accuracy of the azimuthal localization of a virtual sound image. The results of subjective tests revealed that reflection created using a listener's own HRTF (individualized) is more effective for localizing sound than that created using someone else's HRTF (non-individualized). However, the performance was comparable with cases where only direct sound was presented.

[pdf version]

Toward HRTF personalization: an auditory-perceptual evaluation of simulated and measured HRTFs

Parham Mokhtari, Ryouichi Nishimura and Hironori Takemoto

Abstract Sound localization tests were carried out with two subjects using a Virtual Auditory Display (VAD) to determine the intersubject effects on localization accuracy, of employing either acoustically measured or Finite Difference Time Domain (FDTD)-simulated Head Related Transfer Functions (HRTFs). Results indicate that the simulated HRTFs were able to yield comparable localization performance and carried sufficient acoustic cues for personalization.

[pdf version]

On the use of sound for representing geometrical information of virtual objects

Simon Shelley, Miguel Alonso, Dik Hermes and Armin Kohlrausch

Abstract This study is concerned with the use of sound in a multimodal interface that is currently being developed as an aid for product design. By using this interface, the designer is able to physically interact with a virtual object. The requirements of the interface include the interactive sonification of geometrical data, relating to the virtual object, which are otherwise practically undetectable. We propose a classification scheme of the sound synthesis methods relevant to this application. These methods are presented in terms of the level of abstraction between the virtual object and the sound produced as a result of the user's interaction. Finally, we present an example that demonstrates the advantages of sonification for this application.

[pdf version]

Real-time sonification of physiological data in an artistic performance context

Loic Kessous and Christian Jacquemin and Jean-Julien Filatriau

Abstract This paper presents an approach for real-time sonification of physiological measurements and its extension to artistic creation. Three sensors where used to measure heart pulse, breathing, and thoracic volume expansion. A different sound process based on sound synthesis and digital audio effects was used for each sensor. We designed the system in order to produce three different streams clearly separables and to allow listeners to perceive as clearly as possible the physiological phenomena. The data were measured in the context of an artistic performance. Because the first purpose of this sonification is to participate to an artistic project we tried to produce an interesting sound results from an aesthetic point of view, but at the same time we tried to keep an auditory display highly correlated to the data flows.

[pdf version]

DEMOS

Sonification of a complex computational process: computational fluid dynamics

Edward P. Childs

Abstract A live demonstration of the real-time sonification of a complex numerical calculation of a computational fluid dynamics (CFD) simulation is to be performed. The CFD process is implemented in a Java programming environment using JSyn as the sound synthesis tool. A FM Formant Instrument (3 oscillators) is used as the main unit generator (a total of 26 instruments are used to represent computational cells in the domain). All parameters of the instruments, together with the envelopes of each sound event, are mapped directly from the computational process in real time. The computational process is iterative in nature, hence the listener experiences the unfolding of lengthy "phrases" which pan from left to right and represent the "marching" of the solver through the computational domain.

[pdf version]

▶ [Brief recorded excerpt of one computational fluid dynamics sonification / .mp3]

Sound editing on the sonogram

Niels Bogaards

Abstract Sound editing applications commonly use a waveform display to graphically represent a sound signal. This representation not only conveys little information relevant to sound design, it also severely limits the ways in which the user can interact with the sound. By placing the sonogram at the center, AudioSculpt provides a more intuitive and insightful visualization, while at the same time allowing new ways of interacting with the sound's content, such as copy/paste of parts of the spectrum.

[pdf version]

The IPEM_EME: a Wireless Music Controller for Real-time Music Interaction

Michiel Demey, Marc Leman and Olmo Cornelis

Abstract The IPEM_EME is a sound and music controller based on wireless motion sensors and concepts of embodied music cognition. This paper and demonstration aims at further testing the public acceptability of the IPEM_EME.

[pdf version]

DURCHEINANDER. Understanding clustering via interactive sonification

Till Bovermann, Julian Rohrhuber and Helge Ritter

Abstract With Durcheinander we present a system to help understand Agglomerative Clustering processes as they appear in various datamining tasks. Durcheinander consists of a toy dataset represented by several small objects on a tabletop surface. A computer vision systems tracks their position and computes a cluster dendrogram which is sonified every time a substantial change in this dendrogram takes place. Durcheinander may be used to answer questions concerning the behavior of clustering algorithms under various conditions. We propose its usage as a didactical and explorative platform for single- and multi-user operation.

[pdf version]
http://tuio.lfsaw.de/durcheinander.shtml

AUDIODB. Get in touch with sound

Till Bovermann, Thomas Hermann and Helge Ritter

Abstract In this paper we present AudioDB, a system to collaboratively navigate sound databases via a spatial audio-haptic setup. It provides an environment to sonically sort, group and select sounds which are represented as physical artifacts on a tabletop surface. We give an introduction and insights on implementing interactive overviews for sound databases followed by first impressions of a qualitative analysis of the system.

[pdf version]
http://tuio.lfsaw.de/audioDB.shtml

- [AudioDB.avi]
- [flash video (browser)]

WORKSHOPS

Recycling Auditory Displays

organized by Christopher Frauenberger and Stephen Barrass

A workshop on re-using design knowledge Despite the many achievements in the field of auditory display, designing the auditory feedback channel in human-technology interaction only plays a minor role. Designing functional sound is widely perceived as a craft, guidance and methods are scattered in the design space and often highly specialised on specific application contexts. This workshop aims to pull together what we know about auditory display, conceptualise the design space and work towards making this design knowledge re-usable to allow the community and others to effectively build on our research.

[pdf version]
http://www.dcs.qmul.ac.uk/~frauenberger/rad/

Exploring sonic interaction with artifacts in everyday contexts

organized by Karmen Franinovic, Lalya Gaye and Frauke Behrendt

Presentation This workshop introduces participants to the use of creative interaction design methods when exploring the design of sonic interactions with computational artefacts. Specifically, focus will be on physical interactions that rely on continuous sonic feedback. Participants will generate future scenarios and concepts for such interactions, and everyday sounding objects in context will be taken as a starting point. By taking part in the workshop activities, participants will get an embodied understanding of the challenges of designing for meaningful and engaging physical interaction with computational sonic artefacts. Methods employed in the workshop will thus be good complements to the cognition or technology-based approaches to designing sounding objects that are mainstream within the ICAD community.

[pdf version]
http://sonicinteraction.wordpress.com/

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