SMC Sweden 2012
Sound and Music Computing, Understanding and Practicing in Sweden
"Vad pågår just nu?"

April 3-4, 2012
KTH, Stockholm, Sweden
sweden.smcnetwork.org

Proceedings

Special issue of the Speech, Music and Hearing
Quarterly Progress and Status Report
TMH-QPSR, ISSN 1104-5787, Volume 52, Number 1

Edited by
Roberto Bresin, Kjetil Falkenberg Hansen

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Musicking Tangibles for Empowerment

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Extended Abstract

Music and music related activities are important experiences and should be a right [26] in every person's life [8]. Music instruments, with or without computer technology, represent and offers various cultural and interactional possibilities. Within research related to music technology for people with special needs, the focus has been on people's *ability to control the interface* of the instruments [2, 6, 11, 22, 23]. Thereby, in our opinion, great possibilities that computer technology offers, music instruments for wellness and health improvement, has been overlooked. In this paper we present a novel approach towards understanding and design of music technology for people with special needs. To rethink music technology, we combine perspectives from Tangible interaction design with *empowerment* and *resource oriented* music therapy [26, 27].

Tangible interaction design [14] is one of many names concerning design of physical things with computer capabilities [35, 16]. Our focus is on the design and interaction possibilities that lie in the physical, "hybrid" artefact [19, 20], when including computer components such as sensors, network, hardware and software into cultural things. The artefact embodies cultural interpretation possibilities, which we build on when designing and using the artefact [9, 10]. Interpretation of the artefact creates expectations in the user, that develop through interaction over time [1].

The resource oriented and empowerment perspective in music therapy focuses on the *abilities* and strengths of the person, not on their diagnosis or weaknesses. The goal is to *improve vitality*, *self- esteem*, *social relationships* and *participation* through mutual and equal, positive [36], musical experiences [26, 27, 28, 29]. To design music technology with such goals, the challenges shift from the interface to the relation building potentialities of the designs. The focus shifts from controlling the interface [22] to motivating and reward social interaction, co-creation and "musicking" [32]. Musicking is a term developed by the important composer and musicologist Christopher Small. With musicking Small focuses on the equal meaning making and relation building activities related to music, such as listen, playing, composing and dancing. When designing for people with different abilities, motivations and activity intensities, we have to offer many possibilities at the same time, in order to make them share the musicking experience. We have to design music technology artefacts, that are open to many interpretations and musical actions. We call these kinds of music technology designs "Musicking Tangibles".

The paper is structured as follows: In the section, *From instruments to Musicking Tangibles*, we will first present related work we build on from the fields of Assistive Technology related to music [2, 6, 11, 22, 23], HCI, Interaction Design and Tangible Interaction [9, 10, 14, 16, 35]. We also present relevant knowledge from the fields of Musicology [21, 7, 12, 17] to give a deeper understanding of musical actions and experience, especially Small's musicking concept. Further we present current use of music technology in music therapy and the resource and empowerment perspective within the field. We argue for how the resources and empowerment perspective changes the way we think about design of musical instruments and computational artefacts, what we call Musicking Tangibles.

In the next section, *The RHYME-project*, we present our current research project, the first generation of Musicking Tangibles and the multidisciplinary method we use within the project. In the next section, *Observing Musicking*, we present some use cases based on the comprehensive video material we have collected so far [33], to argue for the *differences* between our *Musicking Tangible approach* compared to traditional tool and *interface oriented perspective*. In the *Conclusions* we sum up our contribution to the field, the Musicking Tangibles approach, and how this changes the way we understand and design musical technology, for people with special needs, based on a resource and empowerment oriented perspective. Finally, we present some of the *musicking* limita-

tions we observed in the first generation of Musicking Tangibles. And what we like to include in the next generation like: closer relations between media (sensor, light and sound) and users (physical relation on the floor), new sensory stimulation and new ways to interact and for self expression (camera/projection, own and synthetic voice) to make them more empowering.

(Selection from Outline of the paper)

FROM INSTRUMENTS TO MUSICKING TANGIBLES

State of the art computer based instruments and available assistive music technology

- Electronic music instruments such as tangible and projection based Reactable [18] and music equipment usable as assistive technologies like Sound beam, Opto Sound, Paletto and games like Guitar Hero [13] used in Multisensory Environments such as Snoezelen rooms [25] and Music therapy [15] and everyday situations, recording and playing music.

- From acoustic instruments, with material based stimuli-response to computer based music interfaces [24] with no need for a direct relation between input and output [5, 22 p. 135].

- In therapeutic situations, for people with complex needs, electronic music technology offers new and adaptable ways to interact [23]. This makes music experiences more accessible for people with special needs. Based on studies of music therapists use of electronic instruments, Magee [22 p. 132-133] concludes that the client *first* have to understand the cause and effect, *before* doing complex musical interactions. But Magee also points out problems with fatigue and motivation, caused by too strong focus on trying and failing to master the interface. We argue that *disempowering* and de-motivation of the client takes place in such situations.

Music and action, and musicking relations in musicology

- Research in Musicology of musical actions and expectations [7, 17, 21] and their cognitive [12], aesthetical [34] and musicking [32] everyday [8] use.

Music for health

- A humanist, ecological approach to health as experience of wellbeing rather than cure from illness [3]. Music as a resource for the individual to improve wellbeing by evoking feelings, master the situation, build social relations and shared experience meaning [28, 29, 4].

Empowerment and resource orientation

- Empowerment from a music therapy perspective with focus on the person's strengths and potentials, emphasizing collaboration and equality in relationship between therapist and client [26, 27], collaboration built on Mutuality and Interdependency [36].

Musicking Tangibles for empowerment

- Things carry cultural meanings [1]. Music creates temporal expectation [28]. Cross-media interaction and co-creation of meaning and expectation. Musicking Tangibles motivate and are open to many interpretations, interaction forms and activity levels, where there are no wrong actions [5]. Here we argue against Magee [22]. Everyday musicking experiences with families, friends and care persons (mobile, social, tangible cross-media).

THE RHYME-PROJECT

- 5 years (2011-2015).

- Multidisciplinary project: Music Therapy, Music and Health, Musicology, Interaction Design, Industrial Design, Universal Design, Computer Science, HCI,

- 3 partners: Centre for Music and Health/AHO, Institute of Design/IFI/UIO, Institute of Informatics/NMH

- Goal: To improve health and life quality for persons with severe disabilities, with use of computer-based, networked and multimodal things. Smart things which communicate following musical, narrative and communicative principles. They are interactive, social, intelligent things that motivate people to play, communicate and cocreate, and thereby hopefully reduce passivity and isolation, and strengthen health and wellbeing.

Method

- Multidisciplinary approach, Humanistic and ecological Health approach [3].

- User-centred and Researched-by-Design [30, 31]. New generation of Tangibles will be designed each year based on planed focus (cross-media, mobile media, social media) and analysis of last generation prototypes.

- Action based an empirical study [33] at a School for children with special needs. 5 children with care persons. 4 actions per year.

- First generation Musicking Tangibles developed earlier by 3 project members.

- Future actions and observations will include families and siblings and be made at home, at school and between different environments.

- Video recordings, 3 cameras, Complementary survey every week, Multidisciplinary observation behind glass wall. Multidisciplinary discussions before every action. Analysis of video based on the participants' roles and goals. Multidisciplinary reading and co-writing.

- Centre for Music and Health are responsible for analysis of health effect. Accepted paper will be published in 2012 [33].

First Generation Musicking Tangibles

- 20 wireless soft textile modules with bend sensors and LEDs, 8 musical genres developed in real-time synthesis programming language SuperCollider, full wall projection of dynamic graphic, 2 microphone modules, 8 channel system.

OBSERVING MUSICKING

- Many musical and musicking actions (listen, throw, pat rhythmically, dance).

- Humour and physical vitality not related to controlling the interface, but mediated by the varying background music and varying musical responses, as like a co-musician.

- Many interpretations, expectation, reactions, actions and intensity level. Vary over time.

- Many forms of social interactions, participation and self expressions.

- Dynamic change between interaction forms, action sequences and intensity in the musicking exploration with or without interacting with the interface/computer, but the thing.

- Difficulties to change between musical genres, need more kinds of sensors.

CONCLUSIONS AND FURTHER WORK

- Motivating multitude of positive music related activity where a person with special needs focus on musical vitality not on controlling a tool or interface.

- Changes how we design interface for people with special needs by giving a multitude of possibilities in every situation, instead of focus on one button or sensor. Mastering of the interface is developed through social and mutual explorations. Not taught step by step, going from one level to the next as Magee suggests [22].

Keywords

Musicking, Interaction Design, Health, Music and Health, Tangible interaction, Tangibles, Empowering, Resource oriented, User interaction, Assistive technology, Special needs

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Audiovisuella loopar: ett konstnärligt forskningsprojekt vid Högskolan Dalarna

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Inledning

Upprepningens magi har gett upphov till en mängd kompositionsformer och ligger till grund för ett otal musikstilar. Alltifrån renässansens variationsformer över fasta ackordstrukturer över bluesens 12-takters formler till dagens technomusik. När vi idag talar om loopar och looping menar vi en upprepning av ett musikaliskt parti både som en teknisk arbetsmodell (vi kan t.ex. sätta något i loop i ett seqvenserprogram för att prova en idé, öva eller snabbt få in ett antal tagningar) och som ett konstnärligt redskap där en artist i stunden skapar musikaliska sekvenser vilka återupprepas, överlagras och moduleras med hjälp av olika tekniska hjälpmedel. Det senare har gett upphov till en rad olika stilar med sin egen teknologi alltifrån dub och scratch som använde sig av vinylspelare till hip-hop där samplingsteknik och triggning med hjälp av midi utvecklades. En sub-genre eller snarare en musicerandeform som vuxit fram vid sidan av dessa strömningar är soloartister s.k. liveloopartister som med hjälp av loopteknologin framträder med oftast väl inrepeterade föreställningar där tekniken gör det möjligt att bygga ett ofta imponerande “one man band”.

Tekniken som gör detta musicerande möjligt är olika former av delays oftast konstruerade så att du kan styra dem med hjälp av en fotpedal. Mer avancerade apparater gör det också möjligt att bygga överlagringar (pålägg) och på så sätt successivt skapa ett allt komplexare ljudlandskap. Med pionjären Ecoplex som kom ut på marknaden redan i början av 80-talet så introducerades möjligheten att också kunna synkronisera flera “loopinstrument” med varandra och på detta sätt också kunna loop-musicera tillsammans i ensembleform. Denna möjlighet är fortfarande ett mer eller mindre outforskat fält. Att prova ut denna musicerandeform både konstnärligt och tekniskt genom att bygga ett användarvänligt system för kollektiv livelooping att användas för scenframträdanden är ett av huvudmålen med projektet “Audiovisuella loopar“.

Projektets bakgrund och frågeställningar

Projektet tar sitt avstamp i ett mindre pilotprojekt som genomfördes vid Högskolan Dalarna under HT09/VT10. Detta projekt hade som mål att ta fram teknik och programvaror samt arbeta fram en modell för ett interaktivt konstnärligt agerande mellan teknologi, tekniker och musiker. Konceptet provades sceniskt i samband med ett framträdande med vevlireduon Hurdy-Gurdy och den amerikanska stråkkvartetten Kronos Quartet i Carnegie Hall, New York 13/3-10.

Vidare finns ett önskemål från etablerade Loopartister att också integrera visuell looping för att förhöja närvarokänslan (“live”-upplevelsen) i ett framträdande. En intressant frågeställning är om det är musiken eller loopingfenomenet som är upplevelsen för publiken? Finns det egentligen någon skillnad i om man startar ett konventionellt “backing track” eller en uppspelning av den just inspelade loopen när man trycker på knappen? Kan vi med hjälp av visuell looping skapa en större närvarokänsla för publiken?

En annan frågeställning handlar om teknikens användarvänlighet. Kan vi skapa en “loop- pedagogik” som gör det möjligt för musikanter att, oavsett tekniska förkunskaper, snabbt kunna starta en kreativ process.

Under HT11/VT12 har dessa erfarenheter och frågeställningar legat till grund för konstruerandet av en “loopverkstad” för kollektiv liveloopning tekniken finjusteras och provas ut av ett antal artister från olika genrer. Att sedan integrera denna process med liveloopade filmsekvenser är utgångspunkten för det fortsatta arbetet.

Syfte

Det övergripande syftet med detta konstnärliga forskningsprojekt är att undersöka samt skapa möjligheter för att interaktivt, integrerat och synkront arbeta med ljud och film i konstnärlig gestaltning med hjälp av bland annat livelooptek-nik. En del av resultaten kommer att presenteras i ett audiovisuellt verk i vilket musiker, filmare och tekniker interagerar i ett sceniskt framförande.

Projektet har tre delsyften

- I samarbete med teknikutvecklande företag anpassa programvaror och arbetssätt för audiovisuell loopning utifrån krav och önskemål från loopartister och tekniker från livemusikscenen.
- Att undersöka och dokumentera hur livelooptekniken påverkar musicerandet och skapandet.
- Att i ett sceniskt verk visa på den audiovisuella loopteknikens konstnärliga möjligheter.

Projektbeskrivning

Projektet som drivs inom Högskolan Dalarnas audiovisuella huvudområde pågår t.o.m. oktober 2012 och startade med en inledande workshop juni 2011. Under hösten 2011 har en "Loopverkstad" med möjlighet för fyra musikanter att prova kollektiv livelooping byggts upp. Framtill februari 2012 har ett tiotal musikanter provat tekniken och en del har också dokumenterats med videokamera. Under resten av våren kommer den visuella delen av projektet att integreras i systemet. Detta sker tillsammans med studenter och lokala artister i nära samarbete med några nationellt etablerade artister och ljud- och bilddesigners från livemusikscenen.

Viktigt att lyfta fram är att projektet i första hand fokuserar på livelooping, dvs. artisterna börjar från noll, det finns inget förinspelat material, framträdandet börjar med en tom scen och skärm, inga färdiga filmklipp eller musikklipp, allt skapas och byggs upp i stunden och varje föreställning är unik.

Ett tankeexempel för att illustrera möjligheterna; en musiksekvens spelas på ett instrument och utförandet blir samtidigt filmat (här kan vi tänka oss många möjligheter, artisten i helfigur, närbild på händer och instrument, dansare osv.) när musiksekvensen loopas (spelas upp igen från början) så ser man hur filmklippet samtidigt synkront spelas upp på en skärm. Detta upprepas på fler skärmar med varje musikalisk överlagring och när musikanten slutar spela så har vi ett "liveframträdande" som fortsätter på skärmarna utan musikant!?!

En övergripande frågeställning för projektet är hur genrer och konstnärliga visioner interagerar med teknikutveckling. Detta kommer att undersökas genom att fortlöpande videodokumentera och följa upp sessions i "Loopverkstan" utifrån frågeställningen; hur påverkas musicerandet och musikskapandet av den kollektiva loopteknikens möjligheter.

Förväntade resultat

- En färdigutvecklad teknisk modell för audiovisuell loopning.
- 5 stycken offentliga workshops/seminarier där audiovisuell loopteknik presenteras av etablerade artister och forskare.
- Minst fyra lokala musikgrupper som tillsammans med studenter tagit till sig och arbetar vidare med tekniken.
- Minst en nyskapande föreställning/konsert på professionell nivå där teknikens konstnärliga potential blir prövad.
- En vetenskaplig text som dokumenterar och undersöker hur teknik och kreativitet interagerar med hjälp av liveloopteknik i olika genrer.

Keywords

Looping, live, audiovisuell, kreativitet

Sound for enhanced experiences in mobile applications

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Background

When visiting new places you want information about restaurants, shopping, places of historic interest etc. Smartphones are perfect tools for delivering such location-based information, but the risk is that users get absorbed by texts, maps, videos etc. on the device screen and get a second-hand experience of the environment they are visiting rather than the sought-after first-hand experience.

One problem is that the users' eyes often are directed to the device screen, rather than to the surrounding environment. Another problem is that interpreting more or less abstract information on maps, texts, images etc. may take up significant shares of the users' overall cognitive resources.

The work presented here tried to overcome these two problems by studying design for human-computer interaction based on the users' everyday abilities such as directional hearing and point and sweep gestures. Today's smartphones know where you are, in what direction you are pointing the device and they have systems for rendering spatial audio. These readily available technologies hold the potential to make information more easy to interpret and use, demand less cognitive resources and free the users from having to look more or less constantly on a device screen.

Description of the activities

Two prototypic smartphone applications were developed. The first app was a tourist guide and the second a gaming application. Both applications had multimodal user interfaces based on GPS positioning and electronic compass for input from the users, and a balanced mix of spatial and non-spatial audio, text and graphics as output to the users.

The guide app allowed users to search for points of interest (POIs) and to get guidance to selected locations. To perform a search, the users swept the device horizontally in front of them. As the users swept the device in different directions, the app played a short sound for each POI the users swept by. In this way the users could get an overview of the density of POIs in different directions. When an interesting direction was identified, the users could get more detailed information about the POIs in that direction by tapping an on-screen button. Detailed information was then presented using text and images.

The app could also guide users to selected locations through spatial audio, a graphic arrow and text. The GPS accuracy of smartphones is often not high enough to reliably guide users through turn-by-turn navigation. Instead a method based on the direction to the end target location was developed. The app put a virtual sound source on the target location. Depending on how the user pointed her device in relation to the target, the sound from the virtual sound source was moved between left and right ear. The effect resembled hearing in real-life. The more to the right of the target the user was pointing, the more to the left ear the virtual sound source was moved and vice versa. The users' everyday ability to locate sound sources was used to guide towards the target without the need to interpret more or less abstract information. The direction to the target was also shown with a graphic arrow on the device screen. The distance to the target was encoded into the sound and displayed in digits. Users were free to choose their personal mix of spatial audio and on-screen information for guidance.

The game application used GPS location and pointing direction as input and mainly spatial and non-spatial audio as output. The users' movements in the physical world were reflected in the game's virtual world. Information from the virtual game world about directions and distances to opponents was conveyed through audio. Opponents were found by pointing the device and listening. Attacks were made by pointing and activating an on-screen "fire-button". The damage made by an attack was conveyed through audio to both the attacked player and the attacking player. Current health status was shown graphically on the device screen.

To test the guide application, 24 test users aged 14 to 50 years where enrolled, 15 females and 9 males. The test users were asked to use the app to search for three specified targets and to use the guide function and walk to these. 11 users aged 15 to 30 years, three females and eight males, tested the game application. The test users were simply asked to play the game. After the tests, all test users filled out a questionnaire and took part in focus group interviews.

Results

All users of the guide application managed to use the multimodal search function to get information about the designated targets without problems. All users could also effectively and without problems navigate to these target locations using the multimodal guide function. 75% of the test users stated that they wanted to explore other cities using the application. A NASA Task Load Index showed low overall mental and physical demands and the users reported being successful and unstressed in fulfilling the navigation task. In the focus group interviews, some users reported using the audio feedback to a large extent, both when searching for targets and while getting guidance there. These users appreciated being able to use to application more or less "eyes free". Other users reported relying almost exclusively on the graphical information. Some users asked for greater diversity between the different sounds in order to more easily discriminate between them and their different meanings. One user confused the audio feedback from the application with the ring signal from his mobile phone. At some occasions the sounds from the application was drowned by background noise from traffic or machines. To some users the application did not convey enough information through audio about direction (left/right) or distance to target. Using speech to give the information "turn left" and "turn right" was suggested as a solution.

The test of the game application showed that all players managed to locate opponents by pointing and listening for audio cues. There was also a strong agreement that the players enjoyed playing the game.

All in all the results show that the multimodal interfaces were both effective and fun to use. The spatial and non-spatial audio cues contributed significantly to the overall user experience.

Conclusions

Applications featuring multimodal user interfaces hold the potential to unburden users from cognitive loads and interpretative tasks. Guide applications with such interfaces can effectively help users find points of interest and to guide the way, while at the same time leaving users more free to experience and explore the environment compared to using for example traditional maps. In game applications multimodal interfaces can support rich pervasive gaming experiences.

For a system to give a trustworthy user experience, its information must match the users real-life experience. Low-accuracy GPS data A positive side effect with using virtual sound sources is that they can help overcoming problems with low accuracy in GPS-data. We are used to handle the fact that the eyes can more precisely determine direction and distance to targets compared to the ears. Therefore, auditory guide information based on low-accuracy GPS and compass data can be less disruptive for the user experience compared to visual information based on the same data.

Keywords

multimodal, interface, experience, spatial, audio

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Designing auditory displays for visually dominant user environments

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Interactive Institute

Introduction

Auditory warning signals and alarms are now common elements in many types of user environments, ranging from vehicle cabins to clinical operating rooms to industrial control rooms. The use of sound in these environments may be superior to other modes of interaction, especially in urgent situations that require immediate attention. For instance, sound is omnidirectional (Haas & Edworthy, 2006) and attracts the user's attention regardless of where his or her visual focus is.

Previous researchers have highlighted the sub-optimal use of auditory signals in several user environments (Ulfvengren, 2003; Block, Nuutinen & Ballast, 1999). We suggest that auditory warnings can be designed to more effectively help users avoid danger. Depending on the particular environment, the more effective use of sound in user environments could increase safety, user performance and productivity. Furthermore, auditory warnings tend to be designed and implemented into technical systems without sufficient consideration, affecting such aspects as distraction, perceived annoyance, system acceptance and the overall experience of the working environment.

Ongoing activities

Over the last four years, we have been involved in applied research on the design of auditory warning signals to increase safety in commercial vehicles (Fagerlönn, 2011).

The main aim of this research has been to examine how to facilitate safety using non-speech sounds that inform drivers about potential traffic dangers. Using sound as an information carrier in vehicles is interesting from several perspectives. First, driving is highly demanding with regard to visual attention. The driver must look at the road to drive safely. Second, sound may be used to increase awareness about traffic events that cannot be perceived visually. For instance, sound can inform the driver about events behind the next road crest or in the driver's blind spot.

This project has involved a number of scientific experiments, which were conducted with professional drivers. The studies have evaluated different methods of informing drivers about road events and increasing their situation awareness. The studies have focused on both warning signal efficiency and negative side effects, including annoyance and decreased system acceptance.

Results

When using non-speech sounds to communicate information to drivers, sounds that are both meaningful to drivers and related to the critical event should be used. As compared with arbitrarily mapped sounds, meaningful sounds are significantly easier to learn and can improve drivers' situation awareness much more efficiently. A meaningful sound can for instance be a sound that resembles a bicycle bell to alert the driver of an approaching bicycle. Table 1 shows average response times to meaningful auditory warnings as compared with more traditional arbitrarily mapped auditory warnings. These values were measured in a choice reaction task while the drivers were performing a concurrent driving task and after the drivers had gained experience with the sounds. Twenty-four professional drivers participated in the experiment.

Researchers have reported that commercial drivers' acceptance of the use of meaningful auditory warnings can be quite low. Our results, however, show that meaningful sounds may cause less interference, less annoyance and significantly higher acceptance in some driving situations as compared with arbitrarily mapped sounds. We conducted an experiment, involving 22 truck drivers, to examine initial acceptance of meaningful warning sounds for five dangerous traffic situations. The participants selected one of the following three warning modes for the situations: no auditory warning, a brief abstract auditory warning, an abstract auditory warning followed by a meaningful sound. In two of the situations, 17 and 18 of the 22 commercial drivers preferred the use of a meaningful sound (see Figure 1). These

Table 1: Mean response time and accuracy of response for warnings presented to increase commercial drivers situation awareness.

	Time in seconds (SD)	Error % (SD)
meaningful	3.0 (0.7)	13.7 (10.5)
arbitrary	4.1 (1.3)	33.0 (14.6)
verbal	3.1 (0.6)	12.2 (9.0)

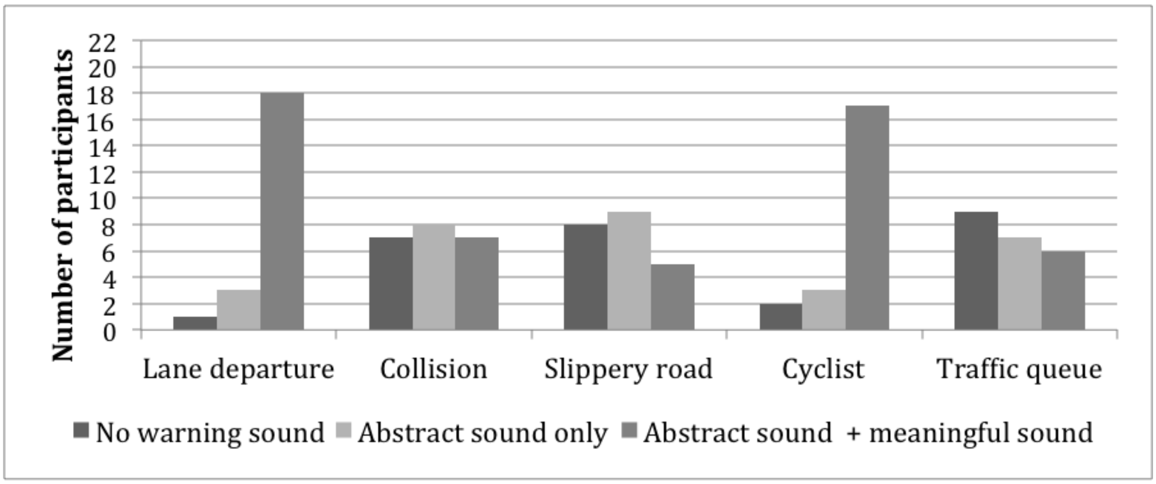

Figure 1: Commercial drivers' selections of warnings for five dangerous driving situations.

results also show that the acceptance of auditory warnings signals among commercial drivers can be very high if the sound has been suitably chosen.

Future steps

Using the auditory channel to both attract attention and inform is a promising concept for many types of user environments. In addition to vehicle cabins, we have begun to work with companies in the process industry to investigate how sound can be used more effectively and appropriately in modern control rooms.

In industrial control rooms, operators are presented with a very large amount of information on visual displays. The systems often use auditory signals, in the form of alarms, to attract operators' attention to critical deviations in the process. In our early investigations in this field, we identified that the design of auditory signals in these environments is usually not given sufficient consideration, resulting in designs that are lacking in several aspects.

Depending on the manufacturer of the control systems the number of priority levels for alarms varies, but are often in the range of three to five. The low priority levels of these alarms may only be shown visually and not given any auditory signal, while the alarms with a higher priority both are presented visually and with a sounding alarm. A problem is that the alarm signals often lack appropriate urgency mapping. Therefore it is challenging for operators to perceive or understand the importance of the situation by listening to the sound. In addition, the operators may have difficulties in discriminating the source of an alarm on the basis of either the direction or characteristics of the sound. By using meaningful sounds with an appropriate urgency we believe that the efficiency may be improved. Alarms of today may also be annoying and do not take into consideration that the operators may have to hear them frequently during the day, and especially in critical situations. We also like to investigate how different designs of these alarms may affect the working environment.

The use of carefully prepared, informative auditory signals in industrial control rooms have a great potential for so much more than alarms. We want to investigate if sound can be used in new types of multimodal interfaces to give information about equipment or process status in these complex environments. By this we hope to find system interfaces that better utilise the human capacity to process information, instead of relying on pure visual solutions.

Over the next few years, we plan to investigate a range of new concepts for auditory displays that will be tested in lab environment as well as industrial control rooms.

Acknowledgment

We want to thank Scania CV AB, Swedish ICT, EU Structural funds, the County Administrative Board of Norrbotten, the Municipal of Piteå, the Municipal of Skellefteå and the Interactive Institute for the funding of these projects.

Keywords

Auditory display, auditory interface, warnings, vehicle design, control room

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Sonification of distance between stations in train journeys

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Background

This study has been conducted in the framework of the ISHT - Interior sound design of high-speed trains project[1]. Main goal of the project is the development of design methods and acoustic artefacts for improving the sound environment in high-speed train of the future. The role of KTH in the project was the testing and design of new sound-based signaling methods for providing travel information to passengers on the train.

Aim of the study

The study at hand presents the testing of sonification for communicating the distance between two stations in a train journey. We wanted to investigate if it is possible to provide the traveller with information about the distance left to the next station by using non-speech sounds. The idea is that of using a sonification independent from culture and language and that can be understood by international travellers.

Method

We designed the sonification of the distance between two train stations by using an iconographic representation of the sound (soundscape) in the landscape outside. When the train was close to a station we mixed typical city soundscapes (car traffic, train station sounds, crowds), when the train got further away from the station, the sonification used was that of a soundscape resembling a natural environment (birds, forest sounds). The sonification would fade out the city soundscape according to the distance from the station, and similarly fade it in when approaching the next station, and making the opposite fading for the rural soundscape.

Nine participants (8M, 1F) of seven different nationalities (China, Germany, Greece, India, Iran, Sweden, Venezuela) took part in a listening experiment. The experiment was conducted on a passenger car on a train during a return trip between Stockholm and Gävle. The distance in each direction was 182 km, with four stops. Both trips had an estimated travel time of 1.5 hour, and the train was on schedule.

The participants were wearing open headphones and during the travel they would randomly listen to either classical music (JS Bach's Brandeburg concertos), two soundscapes that gave a sense of motion (Billström & Atienza, 2012), or just silence. Participants could choose to temporarily switch from the music, soundscape or silent condition and listen to the sonification of the environment outside the train, as often as they wished. While listening, they were asked to rate the sense of how far the train had come on its journey between two stations on a scale from 1 (no sense at all) to 5 (very clear sense). Participants were asked to answer to a post experiment survey composed by six questions for checking the degree of acceptance of the sonifications proposed.

Results

Preliminary results confirm that our sonification helped participants to get an idea of the distance left for reaching the next station. Participants listen to the sonification of the environment outside the train during longer intervals of time when the train was coming closer to the arrival station. More results will be presented at the conference. Post-experiment comments collected from the participants were mainly positive. Here are some of them: "I could divide the distance into five segments according to the type of the outside noise I perceived." "Easy to know the period of the trip, beginning, middle or ending." "Yes it's fun to match what you see with what you hear." "I'm pretty sure it actually does help you get a sense of how far you have travelled, which probably could enhance the travelling experience."

Conclusions

The preliminary analysis of data collected in the experiment suggests that it is possible to use sonification for providing a sense of how far the train

[1] http://ishtkonstfack.blogspot.se/

had come on its journey between two stations by using non-speech sounds. This open for the possibility of developing new sound-based services which can enhance the travel experience from both an informative and aesthetically point of view.

Keywords

Sonification, Sound design, High-speed railroad car

Acknowledgments

The ISHT project has been funded by KK-stiftelsen (The Knowledge Foundation), grant number 2009/0129.

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Sound Environment Center at Lund University - Report Spring 2012

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Studio Report

The complexity of exposure to sound in todays life and urban environment calls for interdisciplinary approaches that encompasses technical, medical, psychological and cultural disciplines to get a broad understanding of the effects of sound on the multitude of levels being involved. Especially since the receiving part, the subject cannot be excluded, being neither stable nor constant, but changing individually with daily status and emotive states in response to the distribution of sounds in cityscape and architecture.

The scientific treatment of sound and sound environment has until recently been largely specialized in a multitude of different disciplines and approaches with highly specialized discourses. Acoustics, audiology, environmental medicine, environment & sustainability studies, psychology, neurophysiology, musicology, cognition, phonetics. . . The list is almost endless.

This list also includes some difficult dividing lines that academic research often has trouble dealing with, such as between humanities and natural sciences. There are also those differences between underlying economical interests in the promotion and production of sound product such as music and software on one side and the scientific understanding and analysis on the other. Top this with trying to relate to the huge subject of the dealing with noise and health aspects of noise exposure and how to develop strategies for action on these. Noise being a internationally high priority area as a steep escalation of noise exposure is predicted for the EU and the rest of the world in the coming decades.

As a response to this complexity Lund university has inaugurated a Sound Environment Center based on a pre-study by doc. Henrik Karlsson in 2005 and has been up and running since spring 2006. Basic functions of the center have annually been financed by the university, while larger research projects apply for funding from external foundations and donators. The center has got an interdisciplinary board appointed by the vice chancellor in consultation with the faculties.

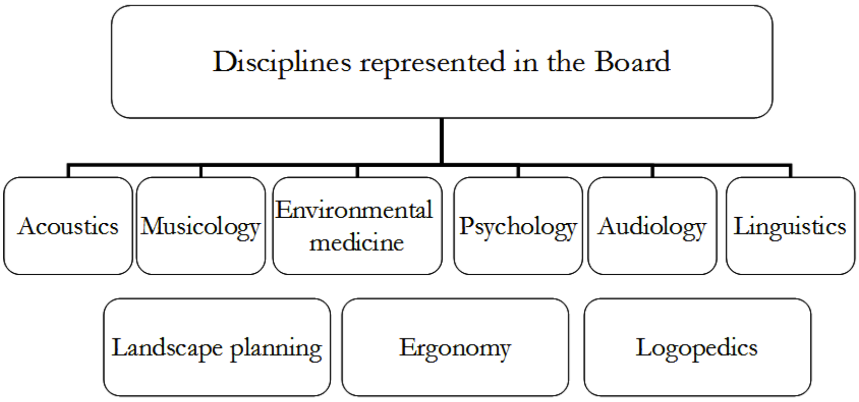
Research projects

The Center provides a scientific framework to initiate research on different aspects of noise problems simultaneously. The research being conducted in the framework of the center is it's core activity, and a number of research projects associated with the center have received external funding. The scope of research is ranging from health aspects in epidemiological measuring of medical prescriptions in populations of noise exposed residential areas, to cognitive aspects as prerequisites for learning, by studying eye movements and skin galvanic response in connection with exposure to various sound sources. Other areas of studies within the framework of the center have been how acoustics affects voice health and performance of teachers, such as the project "Speakers comfort" funded by AFA. This is a large project led by ass.prof. Jonas Brunskog at Technical University of Denmark, DTU, dealing with teacher's voices in different acoustic conditions.

"Health effects from combined exposure to particles and noise" is another large joint project between environmental medicine, acoustics and aerosol technology investigating these questions in chamber experiments. Finally a recent project concerning aging, hearing impairment and our capacities to distinguish instruments and voices in classical music is carried out in collaboration with DTU. Another area we will develop is the spatial role of sound in Virtual Reality environments and this is being done at the Lund Virtual Reality Lab at Ingvar Kamprad Design Center in Lund.

Activities

The Center arranges interdisciplinary symposiums that fill an important role in providing platforms for exchange of information and contact within the university, being a large university providing a wide array of research resources from



medicine to social sciences and music. The symposiums have also incorporated the sound environment research community on national and inter-Nordic levels. As these activities are widening, so are contacts with the international research community also being integrated to a growing extent.

The symposiums have all been woven around current sound environment specific topics with headlines such as *Sound & Health, Hearing Impairment, Sound Design, Seductive Sounds, Sound, Silence & Recreation, Sound in History, Wind Power Noise* and similar. Most of the symposiums result in printed publications. To this day a few, but a growing number, are available in English; “Man, Mind & Emotion”, “Sound in History”, “Man & Sound Environment 2010” and the recent report “Speaker’s Comfort”. Currently a symposium is being planned of how memory and cognition in listeners are affected by light and acoustics, focusing specially on communication of heavy intellectual material in academic education. The center keeps a quarterly newsletter.

Humanities, Natural science and sound

Although the conduct of the center lies within the humanities, as both coordinator and chair are musicologists, we see that the environmental health aspects have hitherto been given domination in our projects and arrangements.

The ambition has been to bring together humanistic and natural science. One problem is that “sound studies” or equivalent names, such as “sonic culture” or “auditive culture” used in the cultural science field, provides a vague research area, still striving to get a solid foothold within cultural studies, not really being clear about how to relate to acoustics and environmental studies. Acoustics is a huge, very active research field, still remarkably few researchers from this field are involved or invited to conferences on “sonic culture” or the like. The reasons are unclear; maybe it is about being afraid of loosing face and not being able to stand up in front the demands of each other’s disciplines. There might be many other answers, of course. The Sound Environment Center is still aiming at connecting these two main perspectives and currently discussions are being held with the department of cultural studies in Lund on creating collaborative courses in soundscape and auditive culture studies.

The Center was awarded The Swedish Acoustic Society’s Large Sound Prize 2008 for “the innovative mobilization of power the center constitutes with an aim to coordinate and initiate interdisciplinary sound environmental projects with the human being in focus.”

The preliminary outcome of the interdisciplinary design shows to provide a creative research environment being both positive and fruitful leading to deepened network collaborations and continuously new research projects.

Keywords

research acoustics, interdisciplinarity, soundscape, health

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Audiorama – publik surroundljudstudio för innovativ lyssnardramatik, elektroakustisk musik och ljudkonst.

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Audiorama – public surround sound studio for innovative listening drama, electro acoustic music and sound art.

Audiorama is a place for listening, a venue with controlled room acoustics and a high tech surround sound system. The goal is to offer world-class experiences – where the sense of hearing is at focus – in the form of music, art and drama as well as pedagogic activity and events. Audiorama works both as a venue and as a programme company, independent and mostly privately funded. During Audioramas first year – 2011 – 131 events took place, with prominent international guests as Morton Subotnik, Trevor Wishart, Benjamin Thigpen and many swedish artists and composers. The program also featured five unique in house drama productions. Sound art, hörspiel *shows and live electronic acts played. Audiorama is now an established venue – a unique place for loudspeaker based art – public available for an audience and for collaborative uses.*

Bakgrund

Audiorama startade år 2005 som en internetverksamhet som erbjöd lyssnardramatik, i liknande form som man kan köpa en ljudbok att lyssna på i sin mediaspelare. Det fanns dock en dröm om att skapa en publik plats där publiken kollektivt kunde lyssna på dramatik, såsom vid en konsert med musik. Den naturliga utvecklingen av denna verksamhet var att sammankoppla flertalet discipliner som olika former av ljudkonst och elektroakustisk musik. Under år 2010 byggdes Audiorama och stod klart i januari år 2011.

Mål

Målet med Audiorama är att erbjuda ljudande konstarter i världsklass – i en akustiskt kontrollerad miljö – där publiken kollektivt kan uppleva berättelser, musik och konst med hörseln som primärt aktiverat sinne. Målet är också att erbjuda aktiviteter runt olika former av auditiv konst såsom pedagogisk, föreläsnings och evenemangsverksamhet och kombinationer av dessa. Tillgänglighet är också ett mål, dels i form av att erbjuda upplevelser där inte det visuella är det primära, men också i form av att tillgängliggöra verksamheten i olika former för olika institutioner, företag och skolor. Dessa mål kan genomföras helt i verksamhetens egen regi eller i samarbete med utomstående aktörer.

Metod och beskrivning av verksamheten

Audiorama fungerar både som en scen för ljudande konstarter och en programverksamhet som producerar privata och publika evenemang. Detta görs genom att personalen fungerar som alltifrån programråd, praktiska genomförare, ljudkonstnärer till publikvärdar, städpersonal och grafiska formgivare. De tre aktiva personalresurserna har specifika funktioner; verksamhetschef, konstnärlig producent och teknisk producent. Audiorama är en oberoende verksamhet i form av ett aktiebolag. Verksamheten är till stora delar finansierad med privata medel.

Resultat

Under år 2011 hade Audiorama 131 evenemang. Dessa bestod i konserter, vuxen, ungdom och barnföreställningar, företagsevenemang, föreläsningar och ljudkonstutställningar. Internationella gäster har varit Trevor Wishart, Morton Subotnik, Trevor Wishart, Benjamin Thigpen, Helen Mirra och Ernst Karel. Uruppföranden av Ragnar Grippe, Savannah Agger, Daniel Karlsson, Sol Andersson, Thommy Wahlström, Mattias, Sköld, Sebastian Lakatos, Per Magnusson, Jonatan Liljedahl, Adrian Knight m.fl. har framförts. Premiärer av Audioramas egna dramaproduktioner *Blodsbröllop*, *När du hör hovar – leta efter Zebror*, *En Sista Sång*, *Resan till jordens medelpunkt* samt *Lille Viggs äventyr på julafton*. Liveelektroniska akter med exempelvis Lise-Lotte Norelius, Ludvig Elblaus och musikperformancegruppen Hidden Mother. Ljudkonst av bland annat Åsa Stjerna och Folke Rabe. Nypremiär för en flerkanalig version av dokumentären *En tisdag i September,* som vann Stora Radiopriset 2011 och framföranden av hörspelen *En kung lyssnar* och *Requiem över en svensk medborgare med anledning av mordet på Olof Palme*.

Audiorama har även samarbetat med *IASPIS*, *EMS*, *SR Radioteatern* och *Kungl. Musikhögskolan i Stockholm*. Programverksamheten har även gästspelat på *Norbergfestivalen* och *Malmöfestivalen*.

Audiorama firade ettårsjubileum i Januari 2012 med ett uruppförande av Jens Hedmans *The Beast With Two Heads* och liveelektronikframföranden av *Micro Modular Ensemble*.

Slutsats

Audiorama är nu en etablerad verksamhet med ett bredd utbud. Lokalens specialdesignade akustik fungerar väl både som föreläsningsrum, konsertsal och mötesrum. Föreställningar, konserter och andra evenemang är publikt tillgängliga för en publik och verksamheten är tillgänglig för samarbetssprojekt och uthyrning.

Keywords

Studio Report, Surround, Electroacoustic, Music

Actors and controllerism (Skådespelare och controllerism)

Erik Hedin

Hedin Sound Design
www.ljudet.com

Bakgrund

I sin bok ”Regi: kreativitet och arbetsledarskap”[2] ger Martha Westin sin egen definition av teater: ”*Teater är gestaltning av liv, av aktörer, inför publik, här och nu*.” Den definitionen inspirerade mig som ljuddesigner att söka ett ”nu” i mitt arbete med ljud. Jag jobbar sedan 8 år som ljuddesigner för scenkonst. Utbildad i ljusdesign för scenkonst på Dramatiska Institutet (nu Stockholms dramatiska högskola) / EMS/NOTAM. Hur finner jag då ett ”nu” i mitt arbete med scenkonst?

Alla produktioner ser olika ut. I resten av detta dokument tänkte jag fokusera på en särskild produktion som jag har gjort tillsammans med Teater MANU/Riksteaten i Norge. Teater MANU är en organisation som skall ”göra teater med utgångspunkt i dövas kultur och miljö.”. Riksteatern i Norge producerar turnerande teater för hela Norge. Det kan i utgångspunkt verka tveksamt att anställa en ljuddesigner till en teaterproduktion för en döv publik. Men i praktiken så tar den döva publiken med sig vänner och familj när de skall se på föreställningen. Denna föreställning skulle spelas av 3 hörande och 2 döva skådespelare. Utmaningen låg i att finna ett meningsfullt uttryck för ljud, för de som inte kan höra. Under ett samtal med Mira Zuckermann, teaterchef på Teater MANU, kom vi på att vi ville göra ett ljud som kunde ses av döva personer i publiken. Som utgångspunkt tog vi den visualizer som finns i iTunes. Denna visualizer påverkas i viss mån av de ljudmaterial som spelas upp. Lösningen blev att en av de döva skådespelarna, Bo, fick möjlighet att kontrollera ljusriggen med sin röst. Då han var tyst blev det skumt på scenen och då han ljudade lystes han upp av strålkastarna. De blev en ögonöppnare för mig som ljuddesigner att jag inte behövde producera ljud under mitt yrkesutövande. Istället kunde jag fånga upp den ljudenergi som fanns och omvandla den till annan meningsfull energi i form av ljus.

Mål

Målet är att uppnå ett mer sensuellt ljudberättande. Vi får en ljuddesign som ”lyssnar” på skådespelaren. Skådespelarens instrument är ju kroppen. Min tanke är att skådespelarna i realtid skall kunna påverka ljudet med sin egen kropp. På detta sätt utvidgar skådespelaren registret för sitt instrument. Istället för att lägga på ett förinspelat ljudlandskap kan jag till exempel generera ljudlandskapet utifrån skådespelarnas rörelser på scenen. Den konstnärliga vinsten med detta är att skådespelarna kan använda ljuddesignen, uttrycka sig genom ljuddesignen och ge ljuddesignen sitt personliga uttryck.

I fallet med den döva skådespelaren, Bo, så skulle den döva publiken visuellt kunna uppleva ljudtrycket i hans röst. Detta upplevs inte nödvändigtvis som interaktivt av publiken, men skapar en unik relation mellan teknik och skådespelare. En relation som i bästa fall resulterar i att skådespelaren och tekniken smälter samman och blir ”ett”.

Metod

Inom scenkonst området utvecklas ständigt ljuddesign-fältet. En intressant aspekt är att ge skådespelaren på scenen mera kontroll över uttrycket på ljudet. Metoden är att utveckla olika styrverktyg som jag ger skådespelaren makt över. För att realisera detta använder jag programmet Max/MSP/Jitter, sensorer och annan teknik. Detta blir ett interaktivt multimediasystem för konstnärligt användande, som ger skådespelaren kontroll över publikens helhetsupplevelse. Man kan se på detta som en ”light” version av controllerism utövad av skådespelaren på scenen. Controllerism är att trigga, ordna eller manipulera förinspelat material och virtuella instrument och effekter.[3] Många personer argumenterar för att

[1] Article ”Take control of your live preformance”, Hollin Jones. January 2012, Music Tech Magazine issue 107

[2] Bok ”Regi : kreativitet och arbetsledarskap” av Martha Westin, tidigare professor i teater regi på Dramatiska Institutet, Carlsson förlag, år 2006

[3] En liknande definition av termen Controllerism återfinns i artikeln ”Take control of your live preformance”, Hol-

Figur 1: Fotografi från teaterföreställningen "Jeg var Fritz Moen" på Teate MANU/Riksteatern i Norge

comtrollerism är en ny form av musikaliskt uttryck. Idag är denna form av interaktiva system mycket billigare, mer stabila och lättare att göra än för några år sedan. Det finns många intressanta användningsområden så som motion capture-system, röst styrda-system och användandet av MIDI-kontroller med skräddarsydd programvara.

I exemplet med Teater MANU så styr den döve skådespelaren ljusstyrkan på strålkastarna med sin röst. Systemet är uppbyggt på följande vis. Skådespelaren har på sig en trådlös mygga (miniatyr-mikrofon). Rösten fångas upp av myggan och överförs av sändaren till mottagaren. Från mottagaren går signalen in i ett Firewire ljud-interface till en MacBookPro. Programmet Max/MSP tar emot signalen. Max/MSP omvandlar signalen till DMX och sänder den sedan vidare till en LAN-Box. LAN-Box skickar i sin tur signalen till ljusbordet. Ljusbordet skickar signalen till ett antal kanal på en dimmer och dimmern sänder slutligen vidare signalen till lamporna. Jag önskar att få fram den signal som genereras av rösten på skådespelarna. En svag röst skall ge ett svagt ljus och en stark röst skall ge ett starkt ljus. I Max/MSP filtrerar Jag bort basen under 100 Hertz med ett högpass-filter. Jag filtrerar sedan bort de svagaste signalerna för att få bort ljudet av andetag och bakgrunds musik. Signalen som blir kvar mappar jag mot DMX-signalen som går ut från datorn.

lin Jones. January 2012, Music Tech Magazine issue 107

Resultat

Ljuddesignen där en döv man turnerar runt hela Norge och påverkar ljuset med sin röst har spelat på 50 orter. Antalet besökande var dubbelt så många som Riksteatern hade budgeterat med och föreställningen vann pris för bästa scenkonstproduktion i Norge år 2011.

En gränssprängande användning av teknik skapade i det här fallet en oväntad kraft. Kanske skapade det en unik kontakt mellan aktörerna och publiken i ett obestridligt nu. Jag vill fortsätta att undersöka detta.

Slutsats

Ljud kan vara ett meningsfullt begrepp även om man inte hör. Döva personer kan använda ljud för att påverka sin omgivning. Detta är ingenting nytt, men kan vara inspirerande att tänka på för alla som arbetar med ljud.

Genom detta kan vi belysa relationen mellan ljudenergi och meningsfull information. Denna sorts system skapar en större variation över vad som är möjligt att göra på en scen. Det liknar det sätt som en musiker uttrycker sig genom sitt musikinstrument, där variation, spontanitet och improvisation är naturliga komponenter. På detta sätt undviker man att ljuddesignen blir en konserverande kraft i en levande teaterföreställning. En kraft som begränsar aktörens möjlighet att agera här och nu.

Keywords

Sound design, stage art, controllerism, interactive, actor

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Synthesis of the Guitar and Player's Interaction

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Background

Large efforts in sound synthesis have been devoted to the development of methods based or inspired by the physics of the sound production mechanisms. The equations and / or solutions derived from the physics are approximated and discretized in order to produce algorithms for the synthesis that are able to operate in real time. Digital Waveguides [1] and Time Domain Finite Differences (TDFD) [2] are among the most widespread methods to achieve efficient computation of the sound samples.

Physics based models are the most flexible sound synthesis methods in which the algorithms depend on physical parameters that can be adjusted to fit different instruments or brands, as opposed to wavetable synthesis, which requires recordings of each note of each instrument played at different dynamic levels.

While other instruments such as piano [3] and clarinet [4] have captured the attention of many researchers, the guitar [4] has been somehow neglected, at least for what concerns expression and control for detailed and high quality synthesis. Nonetheless, the problems involved in order to achieve accurate synthesis are new and not trivial, especially in what concerns the plucking interactions, for example in slap and pop play modes, and the collisions of the strings with the neck or other objects.

Aims

The aim of this research is to achieve realistic synthesis of guitar playing in both sound and player's interaction with the instrument. Methods are extended to other instruments in the family such as bass and ukulele. A commercial plugin, based on our recent results, is under development.

Methods

In our research we focused on the digital waveguide realization of physical models for the vibration of strings. However, our results can be easily extended to other synthesis methods, such as TDFD and modal synthesis as well as to other instruments.

Digital waveguides reflect the forward and backward propagation of waves along the string. Different wave variables can be chosen, such as displacement or velocity, and these variables are described in space and time.

A string oscillates in 3D, which can be described by two transversal polarization modes in planes orthogonal to the string at rest and by a longitudinal mode along the string. Waves are partially reflected at the fret or at the nut and at the bridge, where cross-coupling of the modes occurs, together with coupling with other strings.

For small oscillations, the elementary vibrations of the string are well studied, together with their implementation in digital waveguides. The new ingredients are characterized by special events and interactions, which play an important role for the accurate synthesis of the guitar. In digital waveguides, special nodes are attributed at the locations of these events, which take on the form of linear or non-linear scattering junctions.

One of the main ingredients concerns the way the string is plucked by either the player's finger or the plectrum. We introduced new and accurate models for both finger and plectrum plucking based on mechanical models of these objects.

Another important ingredient concerns the model of collisions of the string with other objects, such as the player's hands, the frets or the neck. A new time-varying scattering junction has been devised that is able to model both elastic and inelastic collisions, as controlled by a restitution coefficient. Collision models are useful in normal play modes when, at intense plucking, the string initially collides with a fret. Collision modes are necessary in order to model pop and slap play modes in which the string is extremely pulled or hammered by the player. Collision models can also be applied to the synthesis of harmonic (flageolet) sounds or to the stopping of the strings by the player's hands.

Accurate models for the fingering at the frets have been developed, which include a friction model for the string oscillations parallel to the frets, driven by the pressure applied at the fret by the player's finger.

Recent work has been devoted to the synthesis of the slide guitar, where the strings are toned by means of a bottleneck. Special vibration modes are excited by the movement of the bottleneck over wound strings, which are modeled by means of a friction system including a scraping noise term. The noise generator is built based on a geometrical model for the deformation of the string windings under the bottleneck. A similar model can be applied to the synthesis of the handing noise when a finger slides over a wound string.

Results and Implications

The ensemble of the achieved results allow for the very accurate and realistic synthesis of guitar playing in all its major components. Not only strings but also the frequent style dependent interactions of the player with the instrument are modeled.

The results are being implemented in a commercial plugin, a free prototype being available which does not include the latest developments. The plugin allows for playing the guitar from a keyboard instrument or even from a guitar-like midi interface. Changing the physical parameters allows for different play modes and interactions and eventually for the playing of various guitar or bass instruments. Sound examples and free plugin available at http://webstaff.itn.liu.se/ giaev/soundexamples.html

Conclusions/Specific value and meaning

In this presentation we summarize results achieved in the past five years of research focused on the accurate synthesis of guitar [6]-[11]. The results are the output of international cooperation, with CCRMA Stanford and with University of Budapest, to which postdoc, master students from LIU and exchange students from the Ècole Polytechnique, Paris and Aix-Marseilles participated. Work is still in progress.

Keywords

Sound Synthesis, Physical Models, Guitar, Pluck, Digital Waveguides

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Musical Beliefs in Creative Communication

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Background

In order to actively participate in a creative musical communication one must perform intentional acts that go beyond synchronized score following, to do that while keeping up coordination one need some understanding of the musical situation as well as the co-players understanding of the situation. In order to believe, know or understand anything one needs some kind of learning ability. While comparatively simple, often statistically based, machine learning methods can lead pretty far it is rather evident that it is not the whole story. If we want to model creative musical communication we need to represent the situational understanding with a logically richer model than the simple machine learning methods gives rise to. One must be able to model the different meanings and effects that similar sonic events can have depending on how the contextual situation is perceived. The modelling of situational understanding can be achieved with help of musical beliefs. Musical beliefs in turn regulate or guide musical communication acts. Musical communication acts have their reciprocal counterpart in speech and dialog acts. Speech act theory has a comparatively long history dating back to the thoughts and work of J. L. Austin in the mid 1950's. A linguistic utterance may have different meanings and effects depending on what kind speech or dialog act it is perceived as. Today there are a rich body of theories on speech acts including a multitude of logics to capture different kinds of speech acts. There are only a few studies from rather recent years on musical communication acts, in the reciprocal sense, so more work in this area is needed.

Aim

The aim of this study is to look at the kind of logic needed to model musical beliefs underlying creative musical communication acts.

Study

We look at the relations between speech and dialog acts on one hand and musical communication acts on the other and compare differences and similarities. In particular we will look at the problem of real-time synchronization required in music communication. We look at some of the logics of speech act theory. We further look at the two models for handling musical communication acts developed by S. R. Frimodt-Moller respectively D. Murray-Rust. We then suggest, discuss and compare a slightly different approach, based on doxastic logic that is logic of beliefs in this case with a weakening of the Kripke axiom K. We discuss the philosophical grounds for weakening axiom K. We discuss the deductive weakening of our alternative approach. We further look at what expressive benefits we get and how that increased expressive power can guide attitudes towards beliefs, help regulate inductive learning and also guide musical experiments. We look at the relations between attitudes towards beliefs and emotions. We sketch two different logic systems with two alternative weakenings of axiom K and compare the alternatives. We discuss meta-linguistic semantics and model theoretic issues. Finally we look at the proof theory, implementation issues as well as computational issues and see how argumentation logic may come into the picture.

Result

We tentatively advocate, a sub-normal paraconsistent multi-ary dynamic doxastic hybrid modal logic, to model musical beliefs for controlling performance of creative musical communication acts. This logic is more expressive on several accounts than the few earlier logics for musical communication acts. It opens up for fine control of inductive learning that can lead to a deeper understanding to handle more creative musical communication.

Conclusion

This is still ongoing and tentative work in its infancy but this and similar work may in its prolongation help us to better model and understand musical communication. If implemented in a computer system we may conduct fruitful experiments in the area of musical communication, not least creative communication that is difficult to model with simpler methods.

Keywords

Musical communication, speech act theory, doxastic hybrid logic

Rörd av musikens rörelse

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The concept of movement has proved to be important in the history of musical theory and practice. As an enlargement of the different approaches by such philosophers as Schopenhauer, Kurth and Adorno, this paper suggests that the problem of movement should be based on the notion of demarcation. Along with the development of that approach a method in formalizing musical movement for compositional purposes will be presented. Some ideas for applications in musical analysis and machine listening will also be outlined.

Inledning

Rörelse är ett återkommande begrepp inom såväl musikutövning som musikfilosofi. I samband med musikutövning talar vi om rörligt tempo, en melodi som rör sig upp eller ned, hur ett harmoniskt förlopp rör sig från en tonalitet till en annan. Vi kan också på ett begripligt sätt illustrera musikaliska gester och förlopp med rörelser i rummet.

Inom musikfilosofin kan man skönja åtminstone tre riktningar när det gäller rörelse i musiken. Den första använder metaforen och analogin för att beskriva musikalisk rörelse. Johnson and Larson (2003) menar att vår uppfattning av rörelse utgår från vår kroppsliga erfarenhet av tidsliga och rumsliga platser. Denna erfarenhet överförs sedan till musikens domän med uttryck som ”senare i stycket” och ”melodin tar ett stort språng”.

Den andra riktningen ser musiken som en återspegling av metafysiska krafter. Schopenhauer (1916) gör en för sin tid detaljerad analys av hur musikens komponenter är en manifestation av viljans olika stadier. Den rörelse vi finner i musiken är i själva verket en avbild av viljan, den urkraft som ligger bakom världen så som vi förnimmer den. Kurth (1956) har en liknande tankegång och menar att musiken är ett fysiskt ytskikt som emanerar ur en psykologisk rörelseenergi. Hos både Schopenhauer och Kurth är rörelsen något som föregår musiken som fysiskt fenomen. Istället för att fråga efter hur musikalisk rörelse uppstår ur en ljudande struktur vill de förklara hur den ljudande strukturen är ett resultat av underliggande krafter.

Det tredje spåret utgår från dialektiken, varvid musiken i grunden vilar på samma förutsättningar till kunskap och sanning som filosofin. Adorno pekar på att tänkandet, den verksamhet där våra begrepp tar form och prövas, har släktskap med musikens sätt att skapa mening (Goehr, 2008). Dialektikens pendelrörelse i form av frågor och motfrågor kan vi också finna i ett musikaliskt förlopp.

Jag avser att i denna artikel lägga fram ytterligare ett paradigm för musikalisk rörelse som kan sägas vara en syntes av rörelse som kraft och rörelse som dialektik. Jag kommer också att visa hur modellen kan användas för att analysera ett musikfragment, hur rörelse kan formaliseras i samband med algoritmisk komposition, samt peka ut några forskningsfält där begreppet musikalisk rörelse skulle kunna spela en roll.

Rörelse som avgränsning

Att erfara musik är att erfara *form*. Med form avses här en musikalisk gestalt av något slag. En kort ton är en form, en fras är en form, en symfoni är en form. Gemensamt för formerna är att de så att säga måste ha någon form, formerna upprätthåller därför en *avgränsning*.

Låt oss ta fallet med tonen. I det ögonblick vi sätter an en ton på ett instrument utför vi ett *språng* ut mot oändligheten. Språnget åstadkommer en *klyvning* i rummet av alla möjliga former, i samma ögonblick tonen ringar in sin form blottlägger den rummet bortom formen. Tonen blottlägger alla möjliga former utom tonen själv. Givet att rummet av alla möjliga former endast består av ton och tystnad skulle tonen blottlägga tystnaden och tystnaden blottlägga tonen. Givet att rummet består av den tempererade skalans tolv toner skulle en skalton blottlägga de övriga elva skaltonerna och en form av elva skaltoner blottlägga den återstående skaltonen. Att blottlägga innebär här en möjlighet, skaltonen gör rummet med elva skaltoner tillgängligt.

Avgränsningen är ytterst ett sätt att övervinna oändligheten, att gå från intet till något. En form behöver inte ha just den eller den formen, men någon form måste den ha. I avgränsningen klyver formen rummet av alla möjliga former och upprättar dikotomin mellan avgränsningens båda sidor, inom och bortom formen. Klyvningen är i själva verket ett moment av rörelse som frigör de krafter vi erfar som musikens rörelse.

Rörelsen i musiken

Genom att analysera musikfragmentet i figur 1 kan vi se hur avgränsningar mellan musikens gestalter befinner sig i konstant omprövning i lyssnandet. Sprången förbereds och fullbordas, antyds och inhiberas. Den dialektiska rörelse som uppstår är grunden för den musikaliska formutvecklingen.

Den mest fundamentala skillnaden är den som uppstår när musiken börjar. Språnget in i musiken ($f0$), från ansats till insats, är musikens förutsättning. Stycket får närvaro i ljudandet och vad som hädanefter sker i musiken sker i den närvaron. Stycket ringar i närvaron in ett förlopp, en livscykel.

Första takten initierar i den fundamentala skillnaden en kraftig rörelse som fångas upp av instrumentens ritarderande växelspel mellan ackordtonerna ($f1$). Kraften i språnget mellan frånvaro och närvaro kan verifieras om vi skulle låta första takten föregås av något annat än tystnad. Rörelsen skulle bli annorlunda och därav även växelspelets karaktär. Man kan även verifiera språnget i avgränsningen genom att utesluta växelspelet varvid den inledande rörelsen visserligen uppstår, men den resonerar inte. En sådan dämpad rörelse kan liknas vid att musicera utan efterklang.

I gränsen mellan andra och tredje takten finner vi en förslagsfigur som landar på en ritarderande ton ($f2$). Mittentonen i figuren återkommer som en efterklang i ritardandot. Samma ton (aiss) befinner sig på var sin sida om gränsen mellan förslag ($f3$) och ritardando ($f4$). Övergången mellan förslag och ritardando tillsammans med övergången mellan mittentonens (aiss) två roller skapar en dubbel rörelse. Den ena sidan av rörelsen är språnget mellan förslag och ritarderande ton, den andra är mittentonens skilda roller som länk i förslaget och bärton i ritardandot.

Musik som rörelse

I kompositionsmiljön *Kimon* (Hedelin, 2008) är det möjligt att formalisera musiken i termer av avgränsningar och rörelse. Syftet är att kunna artikulera ett musikaliskt förlopp med utgångspunkt från en övergripande formutveckling. Att komponera i *Kimon* innebär att låta musiken växa fram som ett resultat avgränsningarnas rörelse.

Analysen i föregående avsnitt urskiljer fem former, fragmentet i sin helhet $f0$, växelspelet $f1$,

Figur 1: Utdrag från Akt *(Hedelin, 2005).*

förslag med ritardando $f2$, förslaget $f3$ och ritardandot $f4$. Hur dessa former förhåller sig till varandra kan ställas upp som pseudokod enligt formlerna (1) till och med (4). Kod (1) bestämmer att den rörelse som uppstår i och med musikens början klyver $f0$ i formerna $f1$ och $f2$. Kod (2) bestämmer att den rörelse som emanerar ur avgränsningen mellan $f1$ och $f2$ skall fångas upp som R i $f0$. Kod (3) bestämmer att rörelsen i $f0$ klyver $f2$ i formerna $f3$ och $f4$. Kod (4) bestämmer att den rörelse som emanerar ur avgränsningen mellan $f3$ och $f4$ skall fångas upp som R_1 i $f2$, samt att den rörelse som emanerar ur mittentonens skilda roller i $f3$ och $f4$ skall fångas upp som R_2 i $f2$.

$$f0 : \infty \Rightarrow f1, f2 \tag{1}$$

$$f1, f2 : f0 \Rightarrow R \tag{2}$$

$$f2 : f0 \Rightarrow f3, f4 \tag{3}$$

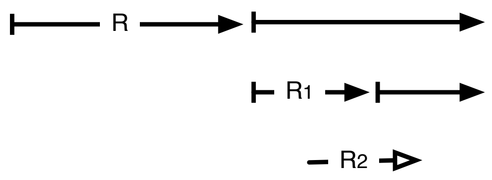
$$f3, f4 : f2 \Rightarrow R_1, R_2 \tag{4}$$

Ovanstående sammanfattar de krafter som verkar i musikexemplet i figur 1. Givet dessa krafter är det nu möjligt att artikulera en annan ytstruktur än det exempel som ligger till grund för pseudokoden. Det är naturligtvis också möjligt att komponera en kedja av avgränsningar och rörelser utan föregående analys av en given ytstruktur. Denna strategi bygger således på att musiken artikulerar ett underliggande kraftspel, och att komponerandet består i att röra sig mellan detta kraftspel och det klingande ytskiktet.

Analys av rörelse

Förutom att använda avgränsning som ett sätt att förhålla sig till komposition torde begreppet kunna tjäna som ingång till en fördjupad förståelse av rörelse som musikaliskt fenomen. Här ser jag i första hand två huvudområden för tänkbara tillämpningar:

Inom musikalisk analys kan man tänka sig en kartläggning av musikens rörelsemönster. Figur 2 visar de rörelser som blottlades i de två föregående avsnitten. Vi kan se att rörelserna R och R_1 leder till nya avgränsningar, liksom R_2 från mittentonen aiss ligger som en överlappande rörelse mellan två former.



Figur 2: Rörelsemönster från fragmentet i figur 1.

Inom området maskinlyssning kan man tänka sig ett lyssnarmodus som tar sin utgångspunkt i klyvning och rörelseenergi. Poängen med detta förfarande skulle vara att den musikaliska rörelsen från redan avlyssnade avgränsningar finns med som ett ingångsvärde vid framtida avlyssning.

Keywords

form, perception, composition, aesthetics

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The Flow of Music and the Music of Flow

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Extended Abstract

Thanks to the psychologist M. Csikszentmihalyi the concept of flow has become widely known. He defined it as the experience of fluent and effortless functioning where you just forget about yourself and gets totally absorbed with the task at hand. E.g. performing music, climbing a mountain, doing a sport etc. Depending on how you define flow it can for some people (e.g. artists, scientists) be an everyday phenomenon while others say they never experience it. In Csikszentmihalyi's view flow-experiences can be placed on a continuum from something truly magic to other more modest experiences such as being absorbed in making food or playing with your children. In the following I will call the former type "magic" flow and and differentiate it from more "basic" flow. Flow without specification refers to basic flow.

In psychotherapy the presence or non-presence of basic flow is a core issue. People seek therapy because they have lost flow in some or all areas of their lives. E.g. phobias may prevent people from functioning in specific areas or a depression will slow down the whole of one's life. In dynamic psychotherapy you try to find out the reasons for the loss of flow. An example. A woman becomes acutely hopeless and unreal without knowing why. In therapy we could trace the reason back to a conversation with a male colleague at her job. In therapy she realized that unconsciously she had become violently angry at the man but she couldn't express it because nice women don't get angry like that. After feeling her anger, depression and her sense of unreality disappeared – flow was restored.

My basic contention is that there is an intimate connection between flow and music. Sometimes music can in a dramatic way restore flow. Alf Gabrielsson (2008) gives numerous examples in his book "Starka musikupplevelser". of how listening to music can bring people out of deep depressions. In one example it even seemed that a newborn baby's life was saved when its father sang the same lullaby that he had been singing during the pregnancy. Oliver Sacks in his book Musicophilia gives a lot of examples of how beneficial music can be in many neurological conditions. In my research I have focused on one specific form of musical expression. The music in question appears spontaneously, without any conscious decision and often without conscious understanding of the reason for its appearance. I call the phenomenon spontaneous melodies and it refers to the everyday-phenomenon of singing a song or humming a tune without any outside source trigging its occurrence. I have collected several hundred examples of spontaneous melodies (Videgård, 2008). Except for one book "The haunting melody" from 1953 by the psychoanalyst Theodor Reik spontaneous melodies have not been investigated in any depth by psychologists or psychoanalysts.

In the first example my 12 year-old daughter admires her new hair-cut in the mirror. At the same time she sings in a very loud voice: "I get so happy when I see you! I get so happy when I see you!" I see this as a simple expression of joy and flow.

The second example is a bit more complicated. As a psychology student I tried to convince a prominent professor to participate at a conference. However he had a hard time to decide whether to participate or not. At the end he said he would participate if his professor-friend Charlie would do so. I said I could really understand that and thanked him. Somehow though I felt unreal after this telephone-conversation. Suddenly I started to hum a march on the top of my lungs. Not until after several minutes did I recognize the title of the march: Carolus Rex – and that made – aha! – the humming understandable. It was an ironic celebration of Charlie = Carolous Rex. Translated into words the meaning was something like : It's ridiculous you can't decide for yourself but has to hold Big King Charlie's hand to dare to participate. The march restored a sense of genuineness, of coming back to myself and my flow.

It is well known that there is a close connection between music and emotions. However the phenomenon of spontaneous melodies both deepens and widens our understanding of this connection.As I see it music is a temporal phenomenon characterized by a coherent gestalt (as described by the phenomenologist Edmund Husserl) unfolding in time. The essential nature of being in flow is of being part of an organizing activity also unfolding in time. So music is not just expressing emotions but is of the same nature as the basic flow which is essential for all complex human behaviours. The capacity of spontaneous melodies to restore flow without conscious premeditation further testifies to the intimate connection between music and flow. I think this can in part explain the deep fascination music has for us.

Keywords

spontaneous melodies, flow, psychotherapy

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Current research on the human voice at KTH

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Abstract

Speech communication research was the origin of the TMH department, and so our connection to research on the human voice is strong. Voice research is nowadays performed mostly in the Music Acoustics group, with a focus on the voice as a sound generator, especially in singing, but also from a medical perspective. For instance, recently a portable device for logging voice use in the workplace has been developed by Fredric Lindström, and KTH is involved in several studies that explore the possibilities of this device. VoxLog registers phonation frequency, voice SPL and ambient noise SPL over an entire working day on a single charge. Fundamental properties of how the vocal folds generate sound are explored in several projects. The FonaDyn project is concerned with how vocal fold oscillation changes from low to high and from soft to loud, with the intent of improving the interpretation of real-time Voice Range Profiles (VRP), which are a popular form of objective voice assessment. Our professor emeritus Johan Sundberg also remains very active, with a wide range of studies on how the voice is used in various genres and types of singing and speech. These and other examples of current studies on voice production will be given in the presentation.

Keywords

voice acoustics, simulation, singing

Sound and Music Computing at KTH

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Extended Abstract

The SMC Sound and Music Computing group at KTH (formerly the Music Acoustics group) is part of the Department of Speech Music and Hearing, School of Computer Science and Communication. In this short report we present the current status of the group mainly focusing on its research.

Long term vision

The long term vision of the SMC group is "to understand human communication and interaction by sound and music so as to make them a natural part of everyday technology". For example in 10 years from now it will be natural to use non-speech sound feedback instead of graphics when interacting with a mobile device. In addition to the technical foundation the research field of SMC includes behavioural science disciplines for the study of perception, cognition, embodiment, and emotion. We also look at artistic expression, and social aspects of music. For the realization of our vision we consider the SMC roadmap, which was written by eleven European research centres, including our group, for a common research path up to year 2020[1].

Research - trends

Three are the research areas in which the SMC group has been working during the last years:

Voice science - technical vocology: The research trends in this field are the use of integrated physics-based simulation for a more realistic voice synthesis, and the development of tools and methods for the analysis and diagnosis of voice function.

In the field of voice synthesis we are investigating the possibility of unified-domain physics simulation of voice by applying methods from both Numerical Analysis and Computational Biology through collaborations with related research groups at KTH.

In the VR funded project Phonatory Dynamics and States, we are investigating oscillatory states and hysteresis phenomena of the vocal folds.

In collaboration with Karolinska Institutet and industry we are working on a project funded by Vinnova and FAS for the methodological and commercial validation of VoxLog – a portable voice logger.

Music performance: The research trends in this field are mainly MIR – Music Information Retrieval, Emotions in music, and Technology for music therapy applications. We have been investigating the possibility of using new perceptually based features for characterising music in audio files in a project funded by VR – The Swedish Research Council: SEMIR – Semantic Music Information Retrieval.

Under the coordination of the Kunstuniversität Graz we are working in a project on expression, emotion and imagery in music, in which we further develop our Director Musices system for expressive music performance.

During the period 2008-2011, we have been partners of the SUM - systematic Understanding of Music Nordic network, coordinated by Aalborg University, Denmark. Topics investigating in SUM have been the relationships between music, emotion, composition, and realtime interaction. We continuously collaborate in artistic projects that involve analysis, control, modification, and synthesis in interactive computer-aided expressive music performance.

Sound in interaction – motion analysis: The research trends in this field are mainly the understanding of complex control movements in music performance (e.g., control of musical instruments, expression of emotions), sonification of body movements, use of sound in diagnosis, rehabilitation, and therapy (ex: athletes, children with reduced abilities), and design of innovative musical instruments and sound-based interfaces.

In the field of complex control movements, we are investigating the possibility of gesture-based synthesis of violin sounds by analysing violinist bow movements via machine learning. We have also been looking at the acoustics and performance of DJ scratching by analysing and modelling DJs' musical gestures on vinyl. The lat-

[1] http://smcnetwork.org/roadmap

ter research has resulted in a PhD thesis by Kjetil Falkenberg Hansen in 2010.

Sonification of body movements is the main theme of the VR funded project SOM - Sonification of body motion. Sonification is also being applied in the improvement of the performance of athletes in the SONEA - Sonification of elite athletes project.

Ljudskrapan, funded by Promobilia, and Ljudparken (funded by PTS, The Swedish Post and Telecom Authority) are two projects that focus on the design of new methods for sonic stimulation Deaf and Hard-of-Hearing, and especially for children with impaired functions. Our paper describing the research work in the Ljudskrapan project received the best paper award at the SMC Conference 2011.

In the field of sound design we have been working in the ISHT – Interior Sound Design of Highspeed Trains project funded by KK-stiftelsen (The Knowledge Foundation) and coordinated by Konstfack. Our task in the project was the realization of innovative sound-based tools for the communication of information in train travel.

We have currently eight active projects, and our research activity has generated about 57 publications since January 2010, 28 of which have been published in international peer-reviewed journals. More information about our research can be found at http://www.speech.kth.se/smc/smc_research_topics.html.

Art-related research

The SMC group is partner of the Center for Opera and Technology, which is a joint collaboration between KTH and The University College of Opera, Stockholm. Our role in the Center is that of contributing to the technical development of operatic art, including singing voice distance teaching, and new means of expression. Extending Opera, research project by singer and composer Carl Unander-Scharin, was one of the successful activities of the Center during 2011, which also involved a master thesis work by Ludvig Elblaus.

Since 2011 professor Gerhard Eckel from IEM/KUG, Graz has been working within our group with the *Dancing the Voice* project that had its premiere at Folkoperan in Stockholm on March 29th 2012. Dancing the Voice is a sound sculpture that creates links between phonetics and dance and it is based on motion capture technology. The project is a collaboration between the SMC group, Stockholm University, and the University of Dance and Circus, and is supported by Wenner-Gren Stiftelserna.

We have also a continuous collaboration with KMH Royal College of Music including teaching of music acoustics courses at undergraduate level, co-supervision of PhD students, and organization of international workshops and conferences.

During the years Anders Friberg has been collaborating in number of artistic productions including the recent Flying Carpet, a dance installation in collaboration with Anna Källblad, presented at the Art's Birthday Party, Södra Teatern, Stockholm, January 2011.

Outreach: Highlights

Our research results have frequently been noticed by media, and this resulted in a number of appearances in forms of radio, TV, newspaper interviews, reportage, and invited talks.

The biggest impact in 2011 was the cover and full story in the culture section that newspaper SvD Svenska Dagbladet dedicated to our group in March 2011.

In July 2009, Scientific American Mind magazine published an interview with Roberto Bresin on our research on emotions and music in a feature story about music and emotion.

The New York Times cited Anders Friberg in a feature story about music and motion (March 2011).

In December 2011, Kjetil F. Hansen was invited to present the Soundscraper project at TEDxKTH *ICT as a Game Changer* (3500 online viewers).

We have been invited to present an installation based on motion capture for music creation at Forskarfredag 2011 (*2011 Researchers' Night* organized by the European Commission). This installation was visited by about 5500 people in one day, and it was also invited to be presented at the 10 year anniversary of Vetenskap & Allmänhet at Färgfabriken in Stockholm, March 21st 2012.

Researchers of the SMC group have appeared in many SR and SVT programmes, for example Hjärtslag (12 episodes on music- and sound research produced by SR P2).

In 2011 we have started a new collaboration with SR Radio Theatre for the developing of new tools for designing sound effects.

Hosting international symposia and conferences 2010–2013

In the period 2010-2012 we have been organizing thematic workshops such as *Sound is Motion* (Feb 2010), *Music is Motion* (Jun 2011) and *ISon 2010 - Interactive Sonification workshop* (Apr 2010). ISon was the third ISon after those organized in Bielefeld and York. ISon 2010 attracted around 60 people (proceedings are available on-line), and resulted in a special issue of the Journal on Multimodal User Interfaces, which will be published during 2012. In 2010 we organized the international conference *PAS 5 - Physiology and Acoustics of Singing* (August 2010), and in 2012 the first *Sound and Music Computing Sweden* (April 2012).

In the near future we are going to organize the international conference *SMC - Sound and Music Computing Conference 2013*, including the SMC Summer School, in parallel to the fourth decennial international conference *SMAC - Stockholm Music Acoustics Conference 2013* (July-August).

More information about our publications, staff and other activities can be found at http://www.speech.kth.se/smc

Keywords

Sound and Music Computing, Music Acoustics, KTH

Fighting "noise" = adding "noise"? Active improvement of acoustic environments.

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Introduction

The research Project ISHT (Interior Sound design of High-Speed Trains) is an interdisciplinary research project including sound designers, acousticians, psycho-acousticians and composers. The key question in this project is how to actively improve public ambiences characterized by tough sonic conditions, offering a comfortable and more sensible environment, providing intimacy, improving the experience of the place etc. In order to answer to these requirements we need to go further than just "reducing the noise level". Beyond the traditional–and limited–noise control, isolation, absorption or even active noise cancelling, it is possible to modify the way we comprehend these environments by altering its sonic composition. And this can be achieved by subtle addition of new sonic components able to divert the attention from the background environment.

Experiments

Two different possibilities are being examined, tested and evaluated in this research project: (i) introducing new sound elements that cannot be heard individually but will be perceived as a part of the environment, "colouring" it in different ways, (ii) introducing sound compositions that will be perceived as subtle added layers but always in an intimate relation with the environment. This second point considers different scenarios such as open or individual (optional) diffusion, time continuity or discontinuity of the added sound, etc.

Methods

The research methods include "field" observation, enquiries, listening evaluations -in vitro and in situ- and professional public exhibitions as well as collaborations with external composers and designers aiming at opening our research question to other perspectives, experiences and sensorial fields (artistic research, interior design, ergonomics, etc.).

The methodology developed in this project is also being explored in several other projects realized in our research group related to public spaces such as squares, parks, new urban areas, etc.

Keywords

soundscape, auralization, sound design, acoustic design

Computational Models of Popular Music

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Background

Algorithmic composition of popular music is a subject that has received less attention than its classical counterpart (Levetin, 2006). Previous algorithmic models for classical music have often used statistical data (Nierhaus, 2009). The statistical approach to music perception is based on the observation that humans seem to have an unconscious statistical understanding of music, where probable events in music are experienced as pleasurable (Huron, 2006). Results from studies of large melodic databases indicate that there are several melodic properties that potentially can be formalized into a generative model for popular music as well.

Aims

The first aim is to gain an improved understanding of the important aspects of popular music. Songs are examined statistically to provide insights to these different aspects and to provide data for Markov models. The second aim is the development of an algorithmic composer of popular music. Notice that to imitate popular music a challenge is to create enough meaningful repetition on many simultaneous levels. An algorithm that operates more or less at random will produce an extremely "original" melody, even though the average listener will probably not perceive originality but instead randomness and a lack of context.

Method

Initially, different possibilities and techniques regarding algorithmic composition of popular music were explored and methods in algorithmic composition were reviewed. A statistical analysis on data from popular music and folk music was performed in Matlab, Humdrum and Pure Data. The concept of *Global Joint Accent Structure* is introduced, as a way of understanding how melody and rhythm interact to help the listener form expectations about future events. The concept is an extension of the *Joint Accent Structure of melodies* (Jones, 1993).

A program was developed in Java for creating tempo, basic rhythms, chord progressions, phrase structures, the rhythm of the melody and the pitches of the melody as described below:

The algorithmic composer starts by creating a rhythmic foundation (drums). A chord progression for a verse and a refrain is then created based on Markov models and generative grammar. As the harmony is established a phrase structure is created by generative grammar.

Many melodic aspects are taken into account and a total score is aggregated for each note based on, amongst other, the following features:

- **Ambitus** – a regression to the mean pitch is achieved by establishing an allowed ambitus.
- **Harmonicity** – The harmonicity of each note is taken into consideration while evaluating every interval. The lowest score is awarded to large intervals of inharmonic notes, and the highest score is awarded to small intervals of harmonic notes.
- **Repetition** – Repetition by altered variations of earlier notes are encouraged. This involves note length, contour and intervals.
- **Global Joint Accent Structure** – used by the algorithmic composer to find salient positions in the time-domain where the probabilities for notes to occur are increased.
- **Note length** – Note length is evaluated where consideration is taken to tempo, rhythm and harmonic compliance over the length of the note.
- **Phrase arch** – Common melodic phrase arches are encouraged. The default setting promotes convex phrase arches in compliance with the findings of Huron (2006).
- **Good continuation** – The probabilities for the next note pitch are depending on the direction of the pitches in the earlier notes of the phrase.
- **Tonal resolution** – Tonal resolution is achieved at salient positions, often in the

end of a part, where a dominant V chord is followed by the tonic I. A narrowing window of allowed pitches ensures a smooth transition.

A Graphical User Interface was created. The user can fine tune over 100 settings to interact with the composer and the user interface also provides the possibility to play and save created songs. The music is played back with MIDI to provide an easy way of evaluating the music, but it should be noticed that the main effort has been put on compositional aspects.

Results

Informal evaluation of the program output indicates that it generates music in accordance with the style of popular music including aspects such as phrasing, melodic movement and harmonic progression. Listening tests are being performed during the spring.

Conclusions

The statistical approach seems to be feasible for modeling the generation of popular music. The results indicate that algorithmic composition of popular music can be valuable for composers in the field. As the melodies have close resemblance to popular music some of the aspects in human composition has hopefully been captured and can be formally analyzed.

Keywords

Algorithmic composition, Markov models, Statistical analysis, Computer music, Popular music, Global Joint Accent Structure

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Sound feedback for the optimization of performance in running

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Background

Recently, auditory display has become quite popular together with visualization in order to present data or send feedback in different contexts. Psychological studies have concluded that it is really intuitive for the human brain to react to sounds, therefore, the concept of sonification has started to be used in sports and other activities that require a good body coordination and technique. There has also been previous work with sonification in a wide variety of fields, such as: physical exercise, games, and physiotherapy. At KTH we have been recently applying sonification in a couple of projects. In one project we used sonification for improving runner's technique by analyzing the vertical displacement of the runner with a smartphone's accelerometer [4]. Another project was about the improvement of performance in rowing [2,3]. Different sensors were placed in the boat and the oars in order to compute different information like the horizontal acceleration and displacement and send audio feedback to the rowers in order to improve their technique. In another study Barrass and colleagues [1] studied the preferences by casual runners for different types of audio feedback. This was achieved by asking runners to carry a probe logging their preferences among six sonification models. In another study, music was used in three types of sonification of the degree of motoric synchronization in active music listening [8] . The interesting contribution of this study was that the sonification itself was music that changed in different ways depending on how coordinated the movements were.

Aim

Many runners are eager to find a good technique that allows them to improve their performance and reduce the chances of injuries at the same time. By reading books or just taking some advice it is not so easy to correct your own technique, since it requires focusing on the body as a whole and not on a single part of it. That is why runners have recently been looking at new technologies that help them enjoy running even more. By tracking and analysing the runner's movement and sending audio feedback to her we want to design a system that allows for a more intuitive way of correct the pose while running; the runner will receive faster feedback, compared to graphic feedback, and therefore will a better possibility of adjusting the pose in real time.

Method

For the tracking of body movements we are using a Microsoft Kinect camera [5] that in combination with the OpenNI system [6] can create a virtual skeleton with 14 joints of the person being tracked. After different tests, we decided to place the Kinect facing the runner from the back, while she is

running on a treadmill, and align it with the runner's X, Y and Z axes (see Figure 1). The speed, displacement and acceleration of these joints is computed and analysed with Pure Data and then compared to the margins of theoretically good values for a correct technique. Different elements such as the vertical displacement of the torso or the distance where the foot lands from the projection of the centre of gravity are computed from that information, and depending on how close the runner's movements get to the correct ones she will notice a change in the feedback sounds which will make her adjust the pose. This system is tested with runners on a treadmill, in order to check how useful it can be and what can be improved.

Preliminary results and Discussion

So far, an early test has been run at the Sport physiology laboratory of the Swedish Sports Confederations in Bosön [7]. Different positions and angles were tested for placing the Kinect. The best position was found to be at the back of the runner, mainly because it presents less occlusions. From the side there is a very clear view of the gait, but the arms and legs are constantly being hidden behind each other and the body. The ideal position would be from the front, but since all the treadmills have a front panel (see Figure 1), it is not possible to track the runner. Another constrain is that the Kinect has to be exactly in the same axis as the ones we want to analyse the runner with. This means, exactly behind the runner and completely parallel to the ground. Otherwise, it is impossible to calculate many elements of the running gait that are interesting, since the references of the Kinect are completely different from the ones from the runner. Another important aspect is that the motion of the arms cannot be tracked properly, since from the rear, the hands are usually close to the chest, therefore they cannot be seen. Moreover, the elbows are usually close to the body, which makes it quite hard for the Kinect to track them. However, the information of the arms is not so relevant, and the legs can be perfectly tracked, which is our main interest. So far, algorithms for calculating the vertical displacement of the torso and the distance between the centre of gravity's projection to the floor and the landing foot have been implemented. On the other hand, once the possibilities of the Kinect have been tested with a runner, the potential elements to sonify have been determined. Depending on the development of the project and the accuracy of the Kinect, more quantities could be taken into consideration for their sonification. The current list of identified quantities, ranked from the most to the least relevant, if the following:

1. Vertical displacement of the torso.
2. Distance between the landing foot and the centre of gravity's projection to the ground.
3. Horizontal acceleration of the torso (this should be proportional to 2).
4. Tilting of the upper-body (forwards, backwards, and sidewards).
5. Contact time of the foot on the floor.
6. Knee angle.

About the sonification, since the project has not reached that point yet, so far some ideas have been studied and they will be checked once all the elements to sonify are correctly computed. Some of the sonifications that we will test are:

– Applying filters to a song, thus making the song sound normally if the runner performs well, or cutting frequencies depending on the performance in the different sonified elements if the runner does not. An idea would be cutting low frequencies for the lower body mistakes, and cutting high ones for mistakes on the upper body.

– Using different sound models for the sonification, such as a model for the sound of the wind , or that of the sound of a car engine, or others that have been tested in previous works [1, 2].

Keywords

sonification, running, kinect, performance

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[6] OpenNI, http://www.openni.org/

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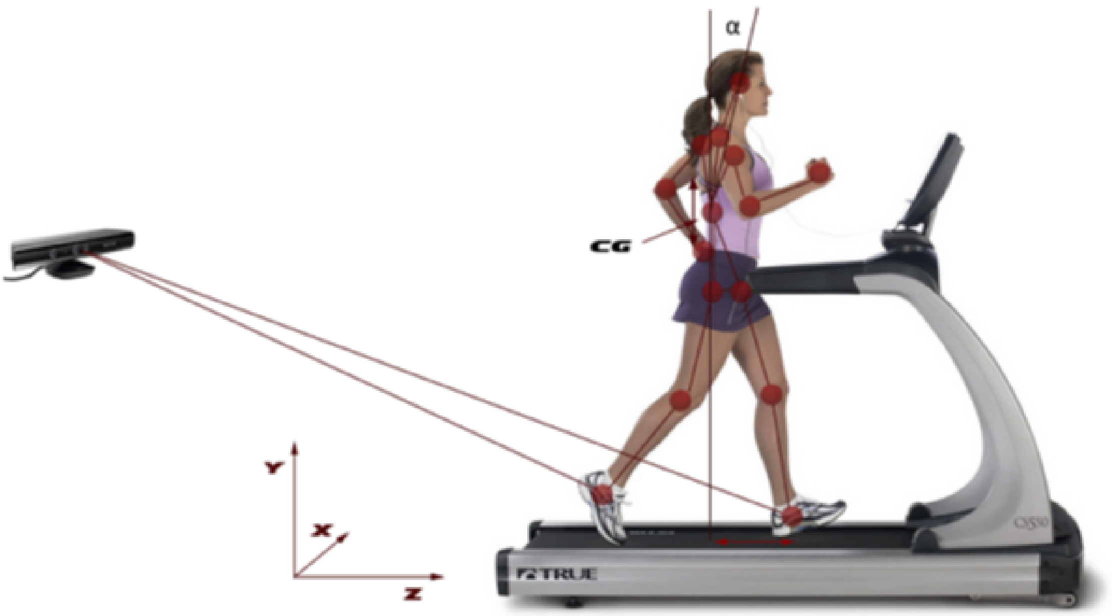

Figure 1: Position of the Kinect camera relative to the position of a runner on a treadmill. The red dots indicated the joints being tracked.

Using modern smartphones to create interactive listening experiences for hearing impaired

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Background

The presented project has been urged by two trends. First, the number of people world-wide with *hearing impairments* is growing. This is due to several reasons such as the increasingly ageing population, listening habits and general sound environment. At the same time, common hearing aids are becoming more sophisticated and new technologies for hearing assistance are emerging. Second, *smartphones* are now more and more dominating the market for handheld computers and mobile phones. They are used for telephony and messaging, but also for listening to music, playing games and experiencing multi-media services on the Internet.

Not everyone can or want to use the sound-based services available. The Soundpark project is about developing applications for smartphones that can enable more users to partake in these services. It is funded by the Swedish Post- och Telestyrelsen, PTS, which has been "assigned by the Government to ensure that crucial services within areas such as telephony, the Internet and postal services are available to persons with functional impairment".[1]

The Soundpark combines resources and research results from several completed and ongoing projects.[2] Ljudskrapan (The Soundscraper) provides means for sound exploration for children with complex needs, accommodating hearing aids and cochlear implants. It has several "sound models" that the user can engage in, initially inspired by how disk jockeys manipulate recorded music. Another major direction is sonification of data, and especially body movements and gestures (SONEA and SOM). Some work has also been done with Symbian mobile devices (SAME).

[1] http://www.pts.se/en-gb/People-with-disabilities/

[2] For details and links see http://www.speech.kth.se/music/sound_projects.html

Goals

The main goal is to present applications on smartphones that encourage active listening, and especially for hearing impaired users. This will require that we also can provide the means necessary for allowing more people to take part of the sound and music applications available. One outcome of the project is a proposal for new methods for hearing training and self-assessment of hearing, based on causal interaction with sounds.

Method

The user interaction is based on using the device's built-in sensors such as inertia (accelerometer, gyroscope), positioning (GPS, compass) and others (microphone, camera, proximity sensor, touchscreen). Users are for the most part given high-level control of the sound as opposed to having detailed control. This reduces the time for learning and mastering the system.

The Soundpark encompasses new applications as well as methods for interacting with existing services such as streaming sound. The implementation is primarily with Pure data (puredata.info) and OSC applications. We use participatory design with user studies and focus groups.

An important undertaking is a state-of-the-art mapping of existing sound-based applications. Results from this mapping show that most applications today are either very simple (a sound effects button, a percussive shaker, a piano keyboard. . .), or copies of existing computer programs (sequencers, equalizers, music players. . .). The mapping is ongoing work as new applications surface continuously.

Acknowledgments

The Soundpark project is funded by PTS, Post och Telestyrelsen.

Keywords

sound interaction, hearing training, hearing impairments, diagnosing, smart phones, Android

Evaluative conditioning: A possible mechanism underlying listeners' emotional responses to music?

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Background

Interest in the psychological mechanisms involved in emotional responses to music has increased in recent years. Researchers have proposed that evaluative conditioning (EC) could be one such mechanism. EC refers to an increase or decrease in the liking of a stimulus (the conditioned stimulus, CS) that results from pairing it with a positive or negative stimulus (the unconditioned stimulus, US), respectively. However, no prior studies have directly investigated EC of music.

Aims

We investigated EC of music using an indirect measure of preference (affective priming).

Method

First, we conducted a pilot experiment to select short excerpts of popular music that were rated as neutral (non-emotional sounding) by listeners (N = 15). Thirty-seven new participants took part in the main experiment, which consisted of two parts: conditioning and evaluation. In the conditioning phase, short musical excerpts were paired with positive and negative pictures from the IAPS database. One musical excerpt (CS-) was always presented together with a negative picture, and another musical excerpt (CS+) was always presented together with a positive picture. In the evaluation phase, the conditioned music excerpts functioned as primes in an affective priming task. In this task, the participants were instructed to judge, as fast as possible, the valence of positive and negative words, and their reaction times were recorded. Each word was preceded by the conditioned music excerpts. Because previous research has shown that response latencies are facilitated when prime and target share the same valence, we made the following hypotheses: (H1) Positive words should be evaluated faster when they are preceded by a positively conditioned piece of music (CS+) than when preceded by a negatively conditioned piece of music (CS-). (H2) Negative words should be evaluated faster when they are preceded by a negatively conditioned piece of music (CS-) than when preceded by a positively conditioned piece of music (CS+).

Results

As hypothesized, we found that positive words were evaluated faster when they were preceded by CS+ music (M = 627 ms) than when they were preceded by the CS- music (M = 641 ms; $t32 = 1.76$, $p < .05$). However, negative words were not evaluated faster when target and prime shared the same valence.

Conclusions

We show, for the first time using indirect measures of preference, that it is possible to use music as the CS in a cross-modal EC framework. However, the evaluative learning effects were observed only for positive words. Taken together, the results suggest that EC may be a valid mechanism underlying listeners' emotional responses to music, at least when the target is positively valenced. EC-effects are notoriously elusive and have been show to vary depending on a range of procedural characteristics. Accordingly, we note that future research could investigate the effects of various procedural changes on EC of music.

Keywords

Affective priming, Cross-modal evaluative conditioning, Music and emotion, Popular music

Music Puzzle: An Application for Hearing Training on Android Smart Devices

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Background

The Music Puzzle is part of an ongoing project called Ljudparken/The Soundpark – Using modern smartphones to create interactive listening experiences for hearing impaired[1].

The aim is to create interactive listening experiences for Deaf or Hard-of-Hearing persons (DHH). The interaction is carried out through using new sensor-based audio interfaces.

Audio-based programs constitute a significant part of the Android Market. Modern smart devices open up new possibilities both in terms of using external information as input and providing real-time audio feedback to the user.

Research Question

Can an easily accessible and attractive puzzle game increase the amount of time of active listening among the DHH?

Method

Music Puzzle is made with a Samsung tablet, GT-P7300 Galaxy Tab 8.9 inches, but should work with other devices running the Android 3.1 operating system. The programming is done in Pure Data[2], Android 3.1, and for the visual representation on the screen also HTML (see examples in Figure 1).

The gameplay consist of the music puzzle where the users are supposed to:

- Shake the tablet to split a file into a number of fragments
- Randomly adjust some sound parameters
- Shuffle the sound pieces and distribute them around the screen
- Listen, judge and rearrange these sound fragments in correct order
- Adjust the sound parameter values to match the sounds perfectly
- Finish arranging all fragments correctly to win the game

In addition, a *testbox* area is available for the user to put a number of segments in any order and play them back, for experimentation and for fun.

Adopted sound parameters:

- EQ
- Combination of Tempo and Pitch

User Input Interface:

- Gyroscope: use shake force to set the length of the fragments
- Multi-touch: for manipulating sound fragments, e.g. drag, play.

Goals

With the Music Puzzle, we contribute to the area of HCI targeting the *serious game* category. In the thesis work we explore, design, develop, and reflect over possible application and game designs for hearing training on personal mobile devices.

Keywords

Hearing, sound interaction, games, design

Acknowledgments

The Soundpark project is funded by PTS, Post och Telestyrelsen.

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[2]puredata.info

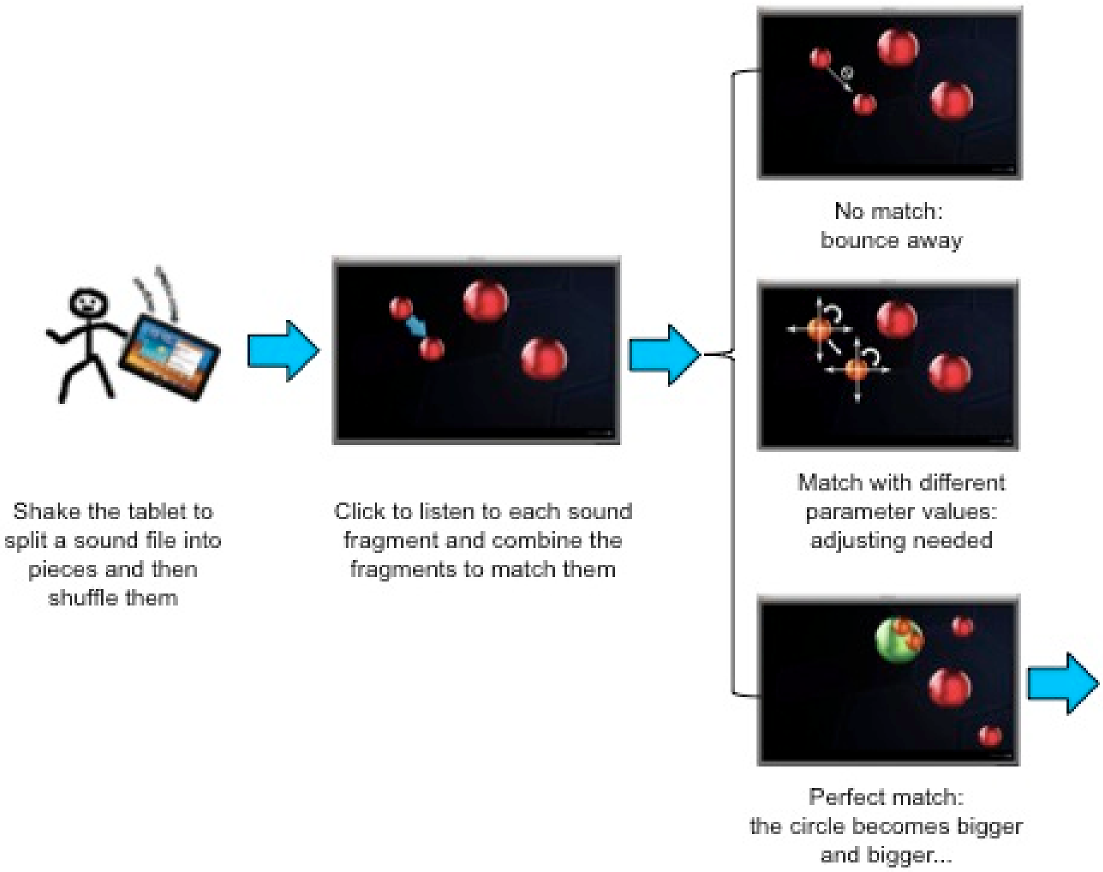

Figure 1: Overview of the gameplay in Music Puzzle.

A framework for spatial rendering of amplified musical instruments

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Background

Spatial audio and its perception in human sound localization have been studied in the last century, producing powerful techniques such as surround sound, binaural synthesis, ambisonics, among others. Nowadays these methods converge on what is called auralization: immersing the listener in a spatial audio experience.

Auralization of MIDI musical instruments has been developed following a framework based on head tracking of the listener, directional characteristics of the instruments, room acoustic modeling and spatial audio processing with HRTF (head-related transfer functions) or surround synthesis [1]. Also, evolved methods regarding modeling of musical instruments have emerged [2], as well as increasing computing capabilities for audio processing; thus nowadays real-time auralization is becoming increasingly easier to implement.

Aim

In order to simulate a realistic immersive audio experience in real-time with a musician playing and moving freely in space, dynamic tracking of the head and the musical instrument by means of a motion capture system is intended, as well as wireless headphone reproduction.

Directional properties of the instruments and room acoustic considerations have to be taken into account. HRTF datasets [3], [4] are used for binaural synthesis, interpolating among discrete spatial responses.

Aiming at identifying the real-time accuracy of the system and perceptual benefits in actual recording/playback schemes, results are expected with multi-track recordings read from disk. Recording tests with instruments and a multi-channel audio interface are intended.

Method

I. Recording scheme

A multi-channel MOTU (Mark Of The Unicorn) interface is used to digitalize the acoustic signal of the musical instrument and send it via FireWire to the personal computer. Preliminary tests with an electric guitar are done, recording with a line-in input of the interface.

II. Motion capture scheme

A motion capture system with eight infrared cameras is used. The tracking software ARENA[1] runs in a primary PC to retrieve the data from the cameras. Data is sent via OSCNatNetClient[2] client to a Pure Data[3] "Network" patch that streams OSC (Open Sound Control) messages to a "Dynamic mix" patch in a secondary PC via UDP (User Datagram Protocol). Latency of the cameras varies from 8.33ms to 10ms. Two rigid bodies are tracked, one in the wireless headphones and one in the musical instrument, each with four infrared markers. Each rigid object provides a coordinate system with six degrees of freedom. The "Network" patch sends X-, Y- and Z-coordinates, yaw, pitch and roll. Yaw and pitch are respectively scaled to azimuth and elevation angles for posterior data processing. This dual rigid-body configuration is tested with an electric guitar.

III. Directional modeling of musical instruments

Considerations in directional sound radiation of the instruments are taken into account. A dynamic filter with 4 overlapping Hanning windows is convolved with the audio signal, using an FFT (Fast-Fourier Transform) block of 8192 elements in a "Directivity" subpatch. Trilinear interpolation is computed, using azimuth and elevation angles obtained from the rigid body in the instrument, and fundamental frequency with two partials calculated from the audio signal. A database of directivity patterns of orchestra instruments[4] was used [5]. This code is tested with a contrabass loop track read from disk.

IV. Room acoustic modeling

[1] http://www.naturalpoint.com/optitrack/products/arena/

[2] http://old.code.zhdk.ch/projects/gesture/browser/branches/active/OSCNatNetClient?rev=2

[3] http://puredata.info/

[4] http://auralization.tkk.fi/node/44

The audio signal is convolved with a room acoustic response, using the Pure Data external "openair " in the mixing patch [6]. An RIR (room impulse response) is loaded, computing an FFT algorithm with a block of 2048 elements. Code for a moving listener is added: loudness perception ratio of direct-to- reverberated sound. A 2-D graphical representation of the room with the sources and the moving listener is coded in Pure Data.

V. Binaural synthesis

Convolution of the audio signal with an HRTF database in the mix patch is made with the Pure Data external "cw_binaural ". HRTF datasets [3], [4] are decomposed into minimum phase and all pass components; thus, an efficient data interpolation is achieved [7]. Wireless SONY (MDR-IF210) headphones are used for playback.

The room acoustic model and binaural synthesis are tested with a multi-track jazz recording read from disk [8]. Piano, bass and drums tracks are positioned in three points of a circumference surrounding the tracked listener.

Implications and preliminary results

- Recording tests with an electric guitar were done, though several tracking problems of the instrument were encountered.

- Noticeable diffraction and occlusion with the human body was found while tracking the rigid object in the electric guitar. Similar behavior is expected for the other instruments.

- Sound localization errors, particularly along the front/back axis, were found to create confusions in the tests with the jazz segment.

- The directivity model of the contrabass loop was found satisfactory. Although problems of signal clipping were found with the when manually varying elevation angles in the "Directivity" patch.

- Quite convincing auralization is achieved by means of the spatial rendering of the multi-track song. Tests with the directivity models should be made.

Conclusions

The preliminary behavior of the framework yields interesting outcomes in terms of its potential for improving perceptual features of recording and playback technologies, as well as motion capture implementation.

Regarding the tracking problems, either the use of more cameras and/or other tracking methods may help to decrease this effect.

An extensive evaluation of the directivity model for the contrabass, as well as the use of data from other instruments, might yield an interesting outcome. Therefore, tests with the directivity model, the room acoustic response and binaural synthesis can be devised.

Coding an individualized HRTF dataset selection with anthropomorphic data of the listener might improve aural perception, reducing the sound localization errors encountered.

Further experiments with simultaneous musicians might yield unsuspected positive results: refining both the quality of their music-making experience, and hence the artistic value of their musical performances. The use of multiple-frequency-bands wireless headphones becomes essential in this case. Tests with professional musicians are planned in the near future.

Keywords

auralization, 3D sound, musical acoustics, recording techniques, motion capture

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