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Journée d'étude ABAV Studiedag - **21 février/februari 2014**

2nd ABAV PhD and young acousticians day

Auditoire 01, Institut de Mathématiques, Université de Liège
Sart Tilman, Grande Traverse 12 (Bât B37 - Parking 32)

PROGRAM

9:30 Welcome & agenda
Dick Botteldooren, ABAV president

9:40 Numerical study of the two-way interaction between flow and acoustics for perforated plates under grazing and bias flows
Jonathan Tournadre
LMS International (Siemens)

The main goal of this doctoral project is the numerical study of the two-way interaction between flow and acoustics for perforated plates under grazing and bias flows. In a first step, the linear regime of the problem is investigated, where the acoustic perturbations are much smaller than the typical values of the mean flow. This assumption allows linearizing the governing fluid equations. Solving the linearized problem is less computational demanding than carrying out Direct Numerical Simulations or Large Eddy Simulation of the fully compressible non-linear flow equations. Linearized Euler Equations (LEE) and Linearized Navier-Stokes Equations (LNSE) codes in frequency domain have been developed based on high order finite element method (PFEM). Validations of codes have been done with comparison with analytical solution in case of simple geometric configurations and flow conditions with a modal analysis approach and further validations are in progress with comparison to results obtained per other numerical tools like Discontinuous Galerkin solver in time domain on more complex physical problems. Acoustic characterization of particular acoustic damping system such as Helmholtz resonators attached to perforated plates are investigated. On a second stage of the project, the nonlinear regime of the problem will be investigated. In this case, the problem becomes more complex to characterize, since the local impedance is not independent on the value of the acoustic excitation. The final goal of this analysis is to provide quantitative information about the acoustic damping behavior of liners and perforated plates for passive control systems.

10:00 Auralization of self-generated sounds in virtual acoustic environments for research in human echolocation
David Pelegrín García
Katholieke Universiteit Leuven

Some visually disabled people are able to use self-generated sounds to detect the presence of nearby objects by listening to the generated sound patterns, applying the same principles as bats do in echolocation.

We describe an auralization system that generates passive virtual acoustic environments, i.e. where the sounds presented to the users correspond to their own voices reflected/scattered by virtual objects — in real time — so that the user has the impression of being in the presence of those objects. The propagation of sound between the mouth and the ears of a person in the presence of an object is characterized by means of the oral-binaural impulse response (OBRIR), which we calculate using the Boundary Element Method (BEM) for the earliest reflection arrivals and ray-tracing software for later reflection arrivals. BEM calculations offer a faithful representation of sound wave propagation and diffraction around the head in the near-field, which is not accurately predicted with state-of-the-art geometrical acoustics software. Low-latency convolution between the voice of the user picked with a microphone and the OBRIRs is performed with the visual programming environment Max 6.1, which is particularly suited for real-time performance, and reproduced via headphones. This system will be used to examine the echolocation ability of visually disabled people.

10:20 Modeling and analysis of nonlinear systems applied to a guitar signal chain

Thomas Schmitz
Université de Liège

The increasing performance of computers and equations solvers have led to a revival in the study of nonlinear systems. The characterization of these systems might be very helpful for engineers and physicists since most of our surrounding natural systems are intrinsically nonlinear. The thesis is largely devoted to methods for analysing and modeling nonlinear systems. These methods are put into practice by modeling a guitar signal chain for real time applications. This chain will ultimately be composed of several elements with different nonlinear behaviors. There is no single method able to model all the nonlinear systems. Therefore several approaches are proposed to fit each system, including a focus on “black box” methods based on Volterra’s series. The physical approach and the study of nonlinearities using tools such as the Spice software provide the basis for the models development. Ultimately, the modelled elements will be: the distortion generator, the tubes preamplifier, the amplifier, the loudspeaker in it's box and the microphone in front of the loudspeaker. Each element of the chain may contain setting parameters that must be taken into consideration in the model. Finally, MIR methods (music information retrieval) and optimization will be used to propose an algorithm providing an automatic setup of the signal chain’s control (gain, low, medium, treble,...). The system will then be able to determine optimized settings to reproduce the sound characteristics of a given musical extract.

10:40 Coffee break

11:00 Audiovisual spatial congruence, and applications to 3D sound and stereoscopic video

Cédric R. André
Université de Liège

While 3D cinema is becoming increasingly established, little effort has focused on the general problem of producing a 3D sound scene spatially coherent with the visual content of a stereoscopic-3D (s-3D) movie. The perceptual relevance of such spatial audiovisual coherence is of significant interest. In this thesis, we investigate the possibility of adding spatially accurate sound rendering to regular s-3D cinema. Our goal is to provide a perceptually matched sound source at the position of every object producing sound in the visual scene. We examine and contribute to the understanding of the usefulness and the feasibility of this combination. By usefulness, we mean that the technology should positively contribute to the experience, and in particular to the storytelling. By feasibility, we mean that a large portion of the spectators in the audience should benefit from this new technology. With respect to the usefulness issue, the objective is to study, in the cinema context, the cognitive differences between a traditional sound rendering (stereophony), and a highly precise spatial sound rendering (Wave Field Synthesis or WFS). In particular, we will examine whether a higher spatial coherence between sound and image leads to an increased sense of presence for the audience. With respect to the feasibility issue, the objective is to evaluate the possible angular error between the sound and the image when presenting precise spatial sound through Wave Field Synthesis (WFS) in combination with s-3D video to spectators seated at different locations.

11:20 The study of soundscape quality in Antwerp city parks

Karlo Filipan
Universiteit Gent

Urban parks are areas of nature and leisure that people often visit because of their favorable characteristics towards acoustic environment. In this study the parks of one of the largest urban areas in Belgium, Antwerp city, were investigated. Measurements included recording with mostly three mobile nodes that were carried by the researchers. The recordings consisted of sound and 1/3 octave band level recordings as well as the GPS position data. During the same time as the measurements were performed, the interviewers were conducting the questionnaires with the parks visitors in order to find out their opinion on various aspects of the parks. The obtained data will be presented firstly by means of created noise maps of parks inside. Moreover, to calculate the sound exposure of each respondent in the study, a range of acoustical indices (e.g. LAeq, LCeq-LAeq, percentile levels) was extracted from the level recordings. The statistical analysis of these acoustical indices, showing the overall exposure during the interviews times, will also be presented. Furthermore, the statistical analysis of interviews data will provide the overview of people's impression on the urban parks included in this study. For the purpose of investigating the overall soundscape quality of urban parks and finding out possible conclusions, further steps will include combination and correlation of objective acoustic indices data together with the subjective interviews responses data.

11:40 An interpolating model to calculate dynamic noise map
Weigang Wei
Universiteit Gent

Different with the strategy noise map from the Environmental Noise Directive, acoustic indicators at locations in between measurement locations can be calculated and updated in a short time by the interpolating model. Indicators can be simple LAeq, but also peak levels, background, number of peaks, etc. The values at the interpolated locations can be used for presenting a more complete picture of the city but also for linking measured data with human observations. The basic assumption underlying the model based interpolation is that there is a reasonably good model for the sound indicators in the area under study but that this model is not very accurate for instantaneous (basic time frame is 15 minutes) level prediction. Inaccuracy may occur in the emission of the source but also in the calculated propagation. The interpolation will tune the source and propagation on the basis of measurements and in that way improve predictions at locations where no measurements are available. The dynamic map could then be used to predict the noise annoyance and sleep disturbance, etc.

12:00 Lunch break & visit Acoustics Lab (ULg)
Lunch is not provided by the organisers. Some cafeterias and restaurants will be suggested in the vicinity of the Institute.

13:30 B-YAN: Belgian Young Acousticians Network
Dick Botteldooren

13:40 Robust sound transmission modelling with a hybrid FE-SEA approach
Edwin Reynders
Katholieke Universiteit Leuven

When considering the sound transmission through a wall in between two rooms, in an important part of the audio frequency range the local response of the rooms is highly sensitive to the presence of random scatterers, while the local response of the wall is rather insensitive to such uncertainty. For this mid-frequency range, an efficient and robust modeling strategy is adopted that accounts for random wave scattering in the rooms. The partition is modeled deterministically, with finite elements. The rooms are modeled in a very efficient, nonparametric stochastic way, as in statistical energy analysis. This strategy is extended so that the mean and variance of the sound transmission loss can be computed as well as the the transition frequency that loosely marks the boundary between low- and high-frequency behavior of a vibro-acoustic component. The method is first validated in a simulation study, and then applied for predicting the airborne sound insulation of a series of partition walls of increasing complexity: a thin plastic plate, a wall consisting of gypsum blocks, a thicker masonry wall and a double glazing. It is found that the uncertainty caused by the random wave scattering is important except at very high frequencies, where the modal overlap of the rooms is very high and a fully diffuse sound field exists. The results are compared with laboratory measurements, and it is found that the uncertainty that is accounted for in the model is well captured.

14:00 Modelling the vibro-acoustic behaviour of stiffened plates using model updating and an FE-SEA approach

Cédric Van hoorickx
Katholieke Universiteit Leuven

Important parameters for the dynamic and acoustic behaviour of stiffened plates are the material properties, the geometry and the positioning of the stiffeners. Uncertainty on these parameters can have an important influence on the sound insulation. To reduce the uncertainty of sound insulation predictions performed with a Finite Element model of the stiffened plate, model updating is used to have an optimal agreement between the modelled and measured behaviour of the structure. A hybrid FE-SEA approach is employed, which has the advantage that the structure can be taken into account in detail by modelling it with Finite Elements (FE). On the other hand, by modelling the rooms with Statistical Energy Analysis (SEA), the method stays computationally efficient. The structure-borne and air-borne sound insulation of the stiffened plates can therefore be obtained accurately and efficiently. Also the variance of the predicted acoustic values due to the diffuse field assumption can be computed. A further advantage of the hybrid FE-SEA approach consists in that the coupling loss factors are computed automatically in a logical, consistent way, so that resonant and non-resonant transmission are automatically accounted for. The method is applied to a stiffened PMMA plate. This allows drawing conclusions about the acoustic behaviour of the plate, the influence of the complexity and detailing of the model, the influence of the position of the excitation on the structure-borne sound, etc. It is also shown that the considered uncertainties are well captured by the presented method.

14:20 Measuring vibration patterns of a building element by means of scanning laser vibrometry

Ludovic Labelle
Katholieke Universiteit Leuven

The understanding of the noise transmission through building elements is of academic but also of practical interest. Whilst the vibration pattern is very complex and strongly dependent on frequency in the higher frequency range, at the lower frequency range building elements do not have a high modal density and are most often strongly resonant. In this work advanced scanning laser vibrometry measurements are used to obtain the full vibrational behaviour of a building element. Examples of operational deflection shapes at frequencies up to 100 Hz are shown. An outlook is given to determine, on the basis of these operational deflection shapes, the radiated sound power of a building element by means of numerical BEM simulations that use the measured velocity distribution as input boundary condition.

14:40 Coffee break

15:00 Human Auditory Attention Modelling and its Application in Sensor Networks

Michiel Boes
Universiteit Gent

The human brain excells at the process of perceiving and analyzing an acoustic environment, also known as auditory scene analysis (ASA). As auditory attention plays an essential role in ASA, it is also indispensable in any computational model trying to mimick it. In order to meet this need, a three-layer recurrent neural network model for auditory source recognition is developed, in which important auditory attention mechanisms emerge naturally from the way neuronal behavior is implemented. Learning in the artificial neural network (ANN) thus becomes attention-driven, causing improved long-term learning characteristics and making the model very suitable for long-term (weeks and even months) noise monitoring in sensor networks. In addition, a novel implementation of short-term memory is investigated and used in the model to improve long-term learning behavior even further. The above mechanisms and implementations are examined and tested on real recordings, made by nodes of a noise monitoring sensor network in a variety of different urban locations.

15:20 Acoustic Monitoring in Environmental Studies Using Automated Bird Song Recognition

Juliette Florentin
Université de Mons

Acoustic monitoring is a rising solution to survey wildlife as required by environmental impact studies and biodiversity management schemes. Sound is particularly well-suited to difficult visual environments (forests, night time, underwater). On land, the state of wild fauna can be inferred from bird populations - and birds can be tracked using their vocalizations. Territorial songs, mating songs and alarm calls all bear markers of species and individuals. The algorithms from the blossoming field of human voice recognition are now expected to process large data streams of nature sounds to yield information about the presence and quantity of bird species at a given location. However, existing studies using state-of-the-art technology stall at a performance of roughly 70% accurate recognition, whereas the numbers exceed 99% for marine mammal sounds. A typical solution involves mel-frequency cepstral coefficients (MFCC) as markers and hidden Markov models (HMM) or artificial neural networks (ANN) as classifiers. Tests were run on a limited database of songs from birds found in the Hainaut province in Belgium and using research software AudioCycle. MFCC are designed to characterize the human voice and fail to discriminate songs that typically operate in a higher frequency range and are recorded in noisy conditions. The neural networks in AudioCycle base their analysis on MFCC and other human voice indicators and consequently produce a flawed map of bird sounds, although classification remains accurate for the most straightforward data. The search for proper bird sound indicators must take into account elements of bird intra- and interspecies communication.

15:40 Music similarity in large scale databases using combined classifiers

Julien Osmalskyj
Université de Liège

Music similarity has received an increasing interest in the Music Information Retrieval (MIR) Community. Similarity for music is a challenging problem whose goal is to retrieve similar tracks to a query in a large-scale database, based on audio content instead of textual information, such as tags. This thesis proposes a novel approach based on the combination of audio classifiers called rejectors. The goal of the thesis is to quickly prune a large database using rejectors in order to only keep a small number of items in the resulting subset, in which a correspondence to an audio query should be found. Rejectors output a probability of similarity between two tracks, based on features extracted from the audio signal. The probabilities are computed using models computed by machine learning algorithms. The overall method is evaluated on the Million Song Dataset (MSD) in terms of the percentage of pruning and a percentage of loss of a rejector.

16:00 Conclusions & drink

16:30 First B-YAN meeting