ACOUCOU ? online platform including interactive educational materials about acoustics

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ACOUCOU - online platform including interactive educational materials about acoustics

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EXTENDED ABSTRACT

Acoustics is a multi-disciplinary field, in which professionals and students are often lack skills, also in some of its sub-disciplines, leading to an overall lack of effective specialists. The ASKNOW project (http://asknow.acoucou.org/) and the associated ACOUCOU Platform (http://acoucou.org/) are part of a strategic plan for expanding and strengthening acoustic knowledge, and for supporting the development of innovative teaching methods based on attractive and effective delivery of content, services, teaching methodologies and practices at national and international levels. The main purpose of the developed courseware is to innovatively bridge theory and practice through digitalization, both in the context of current educational programs and to increase the awareness of professionals about the role that acoustic comfort plays in citizens' everyday life. The goal of acoustic courseware is to design and combine lessons and practical cases within an innovative online experience, stimulating the development of knowledge and allowing solving issues connected with acoustics in a broader perspective.

The course will be a source of acoustics knowledge that will allow the target groups to develop educational skills in specific fields of acoustics, bringing essential multi-disciplinary tools, in order to tackle lack of expertise in certain specializations, for new employees or even new career paths. Open resourced materials available to academic teachers will help them prepare innovative lectures based on the problem-solving approach, supported by examples and implementations from the business and acoustic industry (problem-based teaching and learning). Materials available to professionals will fall in line with continuous professional skills development and enable self-learning in a VET approach. They will also offer a database of solutions to various problems and issues related to acoustics.

ASKnow project will last 3 years (2020-2023). The Acoucou platform will be extended and the following modules are going to be included:
–Acoustics Fundamentals
– Psychoacoustics
– Acoustical Simulation and Auralization
– Electroacoustics
– Room and Building Acoustics

ACOUSTICS FUNDAMENTALS

The aim of this course is to introduce concepts and models which are needed for simulations but also for other acoustic courses. The course starts with the definition of the main concepts of acoustics waves and the order of magnitude of the quantities involved. Then the equations of acoustics and their solutions are developed in one dimension (1D). Various notions are introduced and illustrated by applets on which parameters can be varied: reflection, transmission, impedance, eigenmodes etc. A special attention is paid to time domain description vs frequency domain description. Then the intensity is introduced and the modeling of losses is discussed. In the second part equations of lossless acoustics are developed in 3D and their solutions in cartesian, cylindrical and spherical coordinates are given. Plane waves, cylindrical waves and spherical waves are specifically studied. The question of sources is addressed with the concept of monopole, dipole, quadrupole and the development of compact sources on the basis of spherical harmonics. The concept of directivity is introduced as well as the diffraction. The third part is devoted to bounded fields such as waveguides and cavities. Modes for waveguides are introduced and their difference with that of cavities is discussed. Concepts of cutoff frequency and evanescent waves in waveguides are introduced and the theory of propagation in horns is developed. Modes and resonances in a cavity are studied with and without losses.

PSYCHOACOUSTICS

The psychoacoustics course gives an introduction on how to account for human perception when working with sound. Starting with an introduction about the anatomy of human hearing, the course delves into signal processing as performed by the human auditory system. The course then introduces established psychoacoustic parameters such as loudness, sharpness, roughness, tonality and fluctuation strength, before dealing with more abstract concepts such as annoyance. Binaural hearing is explored first in theory and then through practical applications, dealing with binaural recordings via artificial head and correct binaural playback. Once an understanding of binaural hearing is established, the course continues with the topics of speech intelligibility and speech production before advancing into one of the main tools of psychoacoustic research - the listening test. Herein, a general introduction on how to perform listening tests, best practices to follow, and an overview of common test procedures and related statistics are given. The learned concepts of the course then find practical application within two use cases. The first use case demonstrates the generation of aurally correct recordings and their usage within a listening test to generate a sound quality metric based on psychoacoustic parameters. The second use case involves an example for an psychoacoustical listening experiment examining our ability to localize sound sources.

ACOUSTIC SIMULATIONS AND AURALIZATION

This course introduces you to the world of acoustical simulation and auralization, which is the process of making measured or simulated data audible. For this, some basics of signal processing are covered and the related basics of sound propagation are introduced. Acoustical simulations are very popular in room acoustics, using the simplified concept of ray-based sound propagation. Different approaches, also wave-based models, aiming at predicting the sound field in rooms, are explained. Additionally other simulation concepts, such as the sound transmission between rooms in buildings or in urban outdoor environments are presented. The concept of ear-canal-related signal simulation using binaural synthesis is introduced along with the process of creating auralizations of virtual rooms. As an important application in the automotive industry, the binaural transfer path synthesis is also part of this course. With respect to reproduction, different loudspeaker based concepts are explained in addition to headphone reproduction. The course is wrapped up with several further application examples and the important question how the validity of an acoustical simulation can be assessed.

ELECTROACOUSTICS

As electroacoustics is a multi-physics topic, it will start with refresher trainings on electricity, mechanics and acoustics. These lectures will give a sufficient background for taking on electroacoustics. The following courses will allow end-users to gradually immerse themselves in the different concepts used in electroacoustics. The analogies and couplings between the different physical domains will be discussed first. They will then help to understand how the most commonly used transducers in electroacoustics work and how they interact with their environment. Two practical cases will combine simulations and measurements for a better understanding of the effects of different physical parameters on the system response, and to compare the validity of assumptions made by models with measurements made under similar conditions. In this way, users will be able to understand the challenges related to the manufacture of sensors or sources, the implications of their integration into audio systems and the ways to optimize their characteristics.

ROOM AND BUILDING ACOUSTICS

This course on architectural acoustics covers two main components of the overall acoustic experience and comfort within rooms and buildings. The introduction to the course will explain the difference between room acoustics and building acoustics. The room acoustics part will introduce phenomena related to the behaviour of sound in closed spaces. This part of the course will help the users grasp the basic principles of room acoustics analysis, design and evaluation. The building acoustics part will describe the concept of airborne and impact sound in a building, as well as the direct and flanking transmission of sound through building structures. The transmission of sound through a building element will be quantified by transmission coefficient and the resulting sound reduction index, both for homogeneous and composite elements. Noise in closed spaces will be addressed as the key factor of acoustic comfort, both in terms of external noise coming through building elements and the consequent relation to sound insulation, and of internal noise present in the room due to various sources such as HVAC systems.

ASKNOW project also aims at tackling European issues that go beyond the national level, with the unification of knowledge, through the use of best practices from each country. The consortium will be able to connect many different entities, all interested in supporting educational activities in the acoustic field, which could lead to the further development of the platform that will be used as a space to connect acousticians through European/international networking.

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Figure 1. Project logo.