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DEVELOPMENT OF ICT COURSE MATERIAL FOR ACOUSTICS EDUCATION

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ABSTRACT

Since 1997, an educational project on general acoustics is developed between three Flemish regional universities and one Flemish technical high school. The project has two major goals: to develop multimedia learning environments suitable for specialized studies and to develop a software agent for guidance and assistance by the course. These learning environments are websites and consist of building blocks that can be combined to specific courses. A "guide" is developed for this purpose. This paper will focus on room acoustics by use of a specially developed JAVA-applet. It is developed as a tool for virtual experiments. It calculates impulse responses for a rectangular box shape. The student can change dimensions, distribution of absorption, source characteristics, etc. and read the effects on sound pressure levels, impulse responses, intelligibility, . . . As a conclusion the authors will also comment on the evaluation of the global approach by the students.

1 - INTRODUCTION

The project "Distributed Development of a Virtual Science Museum with Guide Applied to Education in Acoustics" started in December 1997. It has two major goals: to develop multimedia learning environments suitable for specialized studies and to develop a software agent for guidance and assistance by the course. These learning environments are web sites and are linked to a central web "the virtual science museum" (<http://educinno.rug.ac.be/wetenschapsmuseum>). This project uses an open system of distributed development with several partners. In broad disciplines with many sub-disciplines this is a huge advantage, since every partner can develop the learning environments in his primary knowledge field and keep them up to date. As a result every learning environment is developed by one of the best experts in this domain. Because everyone in the cooperation follows the "win-win philosophy" and shares his products with the other partners, everyone is able to profit from the knowledge and the material of the other partners. Obviously this approach together with a review system assures high quality learning environments.

The learning environments are building blocks that the professor can combine in several ways to a course, a case study, etc. A software agent, the guide, is developed for this purpose. This guide consists of a database and a Java applet. Actually, the guide provides the course structure and guides the students through the parts of the science museum they should study. It allows students to browse through the course using back and forward buttons or the table of contents. This concept of a large collection of learning environments (the science museum) and a tool to build the course (the guide) requires however well structured html-pages, on which only a limited number of essential elements (content that cannot be split in single parts) are introduced. For the more essential elements there are on the pages, the less freedom there is to combine them in a course.

2 - AN EXAMPLE: ROOM ACOUSTICS

We will discuss the Java-applet which we developed for the room acoustics web. This web site introduces concepts as reverberation and reverberation time, speech intelligibility and (Rapid) Speech Transmission Index, ray tracing and image method. In order to make the student understand the principles of room acoustics, after having studied the theoretical background, he/she can experiment by utilizing the applet in the "experimentation lab". The applet uses the image method as calculating algorithm and allows the student to simulate the room acoustics of a rectangular room.

Before discussing the way the student can work with the applet, we give a brief description of the image model. In the 'image model' we consider the reflected signal as coming from an 'image' source lying behind the wall at the same distance of the wall as the real source is lying in front of the wall. At a reflection the signal loses a fraction α of its energy (figure 1).

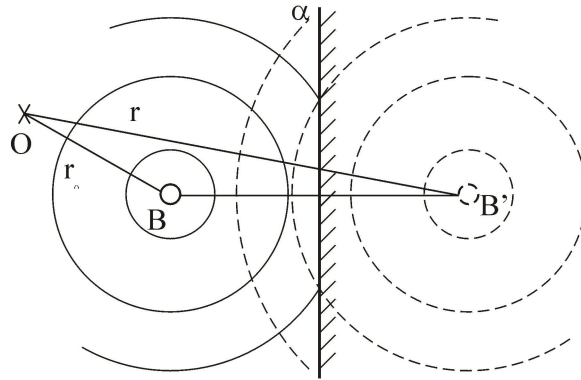


Figure 1.

In a closed space the direct signal is followed by a series of reflections caused by the surrounding walls. Again we can consider the reflections as direct signals sent by 'image' sources which exist through mirroring the room and the real source a lot of times (see figure 1). When the sound source emits a pulse-shaped signal, the arrival of the different 'direct' signals of the 'image' sources form the impulse response of the room.

The image model can easily be implemented in a computer algorithm. For this project a Java- applet has been developed according to the algorithm in reference [1]. The input parameters are the room dimensions, the coordinates of the source(s) and the receiver(s) and the absorption coefficients of the walls. It is in the first place, meant to give the students a possibility to experiment and to learn about room acoustical quantities, and especially about quantities related to speech intelligibility.

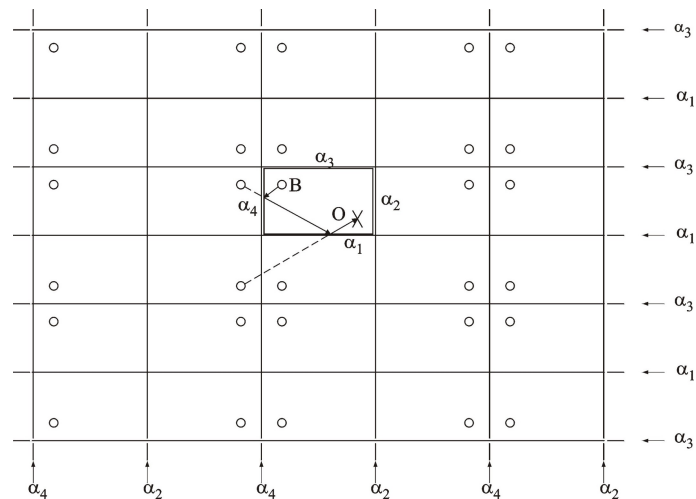


Figure 2.

Therefore, the applet does not allow an infinite number of options: for the walls the student can only choose between some predefined materials, the grid of sources/microphones is generated by the applet

according to the asked amount of sources/microphones and the room dimensions and the frequencies range from 125 Hz to 4000 Hz, which is the frequency range significant for speech. The sources are supposed to be omnidirectional and diffusion is not considered.

Now, what can we do with the applet? The applet allows to calculate the impulse response for specific conditions. So it is possible to discuss single and multiple echo's and specific cases like flutter echoes. The resulting impulse response is available for further processing by the student. The results are also presented as global sound levels at the receiver points and the resulting speech intelligibility is calculated according to reference [2].

For the future we plan to extend the program with an auralisation module. The purpose is to let the student hear a sound sample that has been recorded in the anechoic conditions (no reverberation is present). Then, after convolution with the impulse response of the room, the sound can be heard as if it was played in the calculated.

3 - DIDACTICAL EXPERIENCES: EVALUATION OF THE APPROACH BY THE STUDENT

Some didactical evaluation that has been done in order to test the effectiveness of the applets and self-assessment tools [3]. During the academic year, the students were given an exercise. At the end of the year a survey was held to investigate their appreciation of the use of information technology in education. A group of students in engineering were given an exercise that was conceived as a design project of a good Helmholtz-resonator. All the basic acoustics are explained in the written course notes, the physics and mathematical model of the resonator are not given in detail there. Therefore the students could consult an Internet site, integrated in the virtual museum, where the physics of the resonator are explained in various degrees of depth and where a mathematical treatment is given. An "experimentation lab", provided with an applet, allows the students to investigate the dimensions, etc. of the resonator. There are five possible paths to achieve the correct result going from a rote experimenter – applying blind trial and error – to the path of an expert. In the first path, the students grasp the applet to explore the parameters to accidentally come up with a reasonably good solution. In the last path, the students start the exercise using a simple formula, then investigate more detailed theory and use their own software or the applet to solve the problem. Finally they check if their design is well within the limits of the theory. The concepts that are learned during this exercise depend on the path followed to solve the problem. Every approach should give insight in the operation of Helmholtz resonators.

In addition to the written course material, students had the opportunity to browse through the museum to look for some extra information on the course on a voluntary basis. We will now discuss very shortly some more general questions that were asked.

Most students are convinced that information technology should be used more often in education. Though this does not mean they want to change the methodology (different standards, approaches to the material and examination formats) in education.

The material that needs to be presented on the Internet must be in close relation to the course material, applets need to explore formulas and simulations must explain how things work. The students almost unanimously approve the usefulness of self-assessment tools to evaluate the state of their content knowledge understanding. Most of the students think that hypertext has an advantage in hiding unessential information. However, this is the reason why some students fear to lose the overview of everything they need to study.

In answer to the question if they fear the amount of the course material will increase due to the use of I.T. in the lessons, about half of the students think that learning how to handle I.T. itself will be the supplementary knowledge to achieve.

Nevertheless, half of the students expect a higher workload during the semester, because they will have to work with the new media. They will not be able to handle the course material in a few days before the examination.

Finally, we remark that although the students appreciate the use of ICT in education they still ask for a paper version of the course.

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