ACOUSTICS 2012

Electroacoustic lectures on the web

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An educational collaborative project funded by the foundation "Université Numérique Ingénierie et Technologie" (UNIT), has been recently launched. This project aims at creating a set of lectures on electroacoustics fitted to the web media. This set of lectures will constitute free pedagogical resources available on line. Both basic notions (electro-mechanical or acoustical analogies, transduction principles, etc.) and practical cases (loudspeaker characterisation, enclosures design, etc.) will be presented, making use of available numerical facilities (interactivity, animations, videos, bank of sounds, etc.). Exercises will also be created, allowing the auto-evaluation of the E-learners. All these courses will be presented with a same graphical chart and developed in the SCENARI format. During the presentation, first realisations will be shown and the pros and the cons of this kind of will be discussed during the following discussion.

1 Introduction

Very few french-speaking pedagogical resources on electroacoustics exist today on the web. For the greater part, existing ones are stemming from amateurs' personal initiatives, and are generally reduced to a catalog of recipes which, although they are validated for a long time by the experiment, do not allow to deeply understand the involved physical phenomena. The design of reliable didactic digital resources which fit the requirements of a real scientific approach remains today completely to do.

An educational collaborative project, recently launched and funded by the foundation "Université Numérique Ingénierie et Technologie" (UNIT), aims at creating a set of lectures on electroacoustics fitted to the web media. In the frame of this project, the involved partners will mutualize their own courses and produce new ones in order to build a set of coherent scenarized digital resources. Both basic notions (electro-mechanical or acoustical analogies, transduction principles, etc.) and practical cases (loudspeaker characterisation, enclosures design, etc.) will be presented, making use of available numerical facilities (interactivity, animations, videos, bank of sounds, etc.). Exercises will also be created, allowing the auto-evaluation of the E-learners. All these courses will be presented with a same graphical chart and developed in the SCENARI format.

The profiles of the concerned internet users cover a wide spectre: students, audiophiles, consumers, professionals. But the project is principally thought to produce ressources for bachelor or master degrees. This set of lectures will constitute free pedagogical resources available on line. It can be used as a supplement to on-site courses, in initial trainings as well as in further education.

This paper briefly describes the philosophy and the contents of the courses.

2 Content overview

Electroacoustics is the branch of the acoustics relating to the techniques of production, transmission and recording of electric signals containing information relative to acoustic signals, as well as to techniques of reproduction of the acoustic signals by electric means. It is in the interface between different domains such as electricity, mechanics, acoustics. It requires various fundamental skills (in acoustics, thermal science, optics, magnetism, electricity, signal processing, etc.) and various technological know-how.

This multiphysical aspect led to the development of adapted formalisms allowing to represent the problems under a global approach, partly based on electrical analogies. This formalism usually leads to a representation using electric networks equivalent to the studied physical systems, allowing an easy and fast resolution of problems. Electroacoustics can be seen as a simple modelling tool allowing to approach complex problems, concerning transducers but also other physical systems subjected to acoustic waves or vibrations.

Electroacoustics finds applications in numerous domains: audio applications, telephony, metrology, medical acoustics, active control of the noise, etc. Moreover, electroacoustics knows a renewed interest with the current development of nomadic objects (multimedia mobiles, MP4 readers, computing tablets, etc.) and the development of virtual 3D sound in the common applications (" Wave Field Synthesis ", "High Order Ambisonics"). Knowledge in Electroacoustics is also needed when concerned by acoustic measurements involving sensors and acoustic sources.

3 Description of the course

This project intends to compensate somewhat for the disparity of the educational skills of students attending MSc degrees. Compared to the system in use for many years in France, the current LMD system (BSc, MSc and PhD) allows for a much broader profile among students following the same course. This has many advantages, but requires to provide all pre-requisites to the student when they intend to follow a course dealing with specialized topics - as is the case of Acoustics at the MSc level.

The focus of the project is here named "Electroacoustics", although it may be displayed by a different title in its final form. This topic has been chosen because it is a "speciality" with many attractive applications (multimedia, music, DiY realisations, etc) but also because it may be dealt with in several ways - from basic engineering "recipes" to relatively fundamental methods.

This allows to present the same content with several levels of abstraction, each student being then able to select the most suited to his/her individual skills. The final objective would be to cover levels ranging from the French "baccalauréat" (A level) to the full BSc level. It therefore would aim at giving any student the possibility to get the pre-requisites needed to follow a MSc course, even if such a content is not available in his/her current university.

The "Electroacoustics" UNIT project suggests creating a set of 5 modules segmented in several parts which can be associated to constitute trainings at various educative levels.

The first 4 modules will consist in a theoretical part followed by exercices (MCQ, self-assessment and corrected exercises). The 5th module will be dedicated to case studies. Based on the notions acquired in the previous modules, each case study will answer a concrete question that could arise

once in situation. At the beginning of each module, the necessary prerequisites will be specified , and links will allow to find the necessary on-line resources if needed.

The academic content of the modules corresponds to sections of usual textbooks, as this is convenient for readers looking for a self-contained course. A corresponding conventional document is also intended, probably as a downloadable PDF files for each section, including embedded links to the site. The website content is therefore considered as a complementary presentation, focused on phenomena and illustrations, and keeping the amount of mathematical description to a minimum.

Several alternate entry pages will be proposed, each allowing to start in a different way. For example, a reader could reach the site by using a keyword related to one of the test cases. He/She would then find the description of this topic, but also links allowing to get a deeper understanding of the underlying concepts. The "test case" page would therefore also constitue an entry page for the whole site content, with the advantage of answering to a reader request. This flexibility is one of the great advantage of a web site, the corresponding drawback being a stringent need to sustain the reader's interest unless he/she would just look for another site. Each page must then be very short, and much more illustrated than its printed counterpart.

The proposed project content is still preliminary; it is briefly summarized below, as a rough skeleton. This content is likely to evolve significantly during its development, planned over the two next years.

- Module 1 : The electroacoustic chain
  - The ear as an acoustic sensor
  - Basic notions
- Module 2 : Analogies
  - Electrical systems
  - Mechanical systems and electro-mechanical analogies
  - Acoustical systems and electro-acoustical analogies
- Module 3 : Coupling and transduction
  - Mechano-acoustical coupling
  - Electrodynamic transduction
  - Electrostatic transduction
  - Piezoelectric transduction
- Module 4 : Electro-mechanico-acoustical systems
  - Electro-mecanico-acoustical networks
  - Acoustic loads
- Module 5 : Case studies
  - Measurement microphone
  - Recording microphone
  - Enclosure design
  - Loudspeaker characterisation
  - Loudspeaker feedback

The sustainability of these educational resources will be guaranted by a development on the XML editor "SCENARI 3". The referencing of the resources will respect the standards proposed within the framework of UNIT. The model OPAL will be used for the part "contained disciplinary " and a specific mode will be used for case studies.

4 Example of section structure

Figure 1 illustrates one of the proposals for the structure of a simple section, dealing with the interface between solid and fluid media. It is somewhat organized as a small video game : starting from everyday's life examples, it challenges the visitor at the end of short sequences, each providing a somewhat deeper level of understanding of the section topic than the previous level. Other structures are under study, so this example may not be kept in the final site.

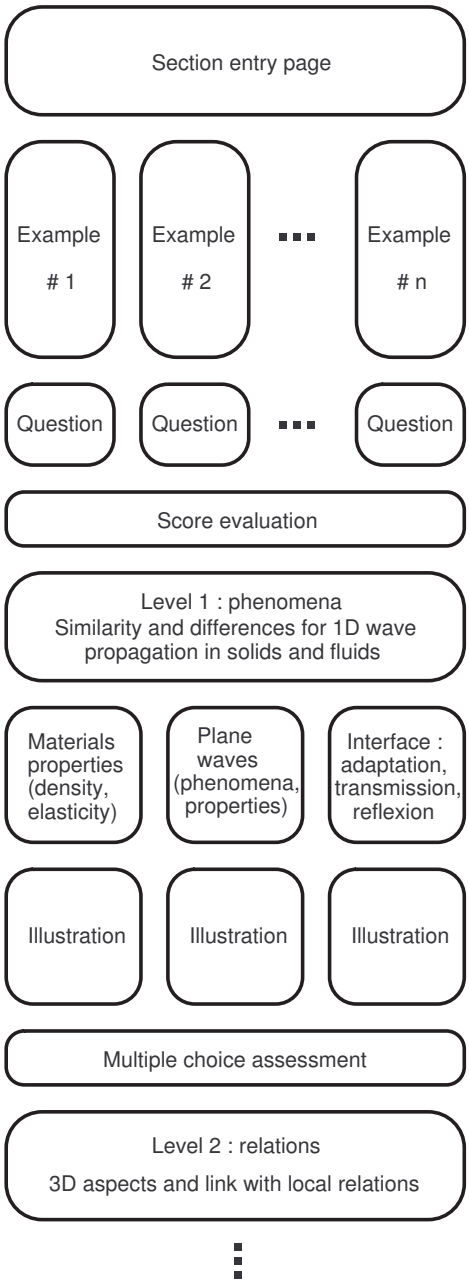

Figure 1: Example structure for one section, dealing with solid/fluid interface

The main features of this approach are :

- Examples are illustrated, allowing ”DiY”
- Level = selection of 3-4 items (example or concept)
- Each item has an associated ”pass/fail” assessment

After ending a given level, the visitor gets his/her score, and has the choice to retry the last item, try another, or even restart at a lower level. The access to the upper level requires a sufficent score, which can be gained by iterating at the current level. A ”bookmark” button allows to record the current level and score, until a further visit.

The last part of the section contains a brief summary of the section concepts, the score reached by he visitor, some links toward additional pages including animated field maps, web links, etc. From there, the visitor may go to several pages of the site : the ”next” section (following the more conventional - sequential - presentation), other sections which content may be considered as related, the top page, or a test case involving the current section content. This multiple choices for exploring the site content is expected to sustain the visitor’s curiosity (and hopefully interest).

5 Work plan

The project started in 2012, and is contributed by several educational teams in France and Switzerland. However, this does not represent much people for a somewhat ambitious development. The work plan is therefore divided in two steps : the first one is to provide a textual content with homogeneous presentation of all aspects of the topic, together with a minimum amount of web pages to complement the text. At this stage, illustrations and scenari will be kept as simple as possible.

The second step should start when the content and structure is almost final; it should bring a better look to the existing pages, but also add much more illustrations, animated sequences, and a few interactive illustrations. This will also be the time to increase the ”gaming spirit” of the sections (implement scoring or other evaluation tools).

Additional content may also be added at any time, either from peripheral contributions (existing content adapted to supplement specific aspects) or as new contribution, if still possible. This may include a few pages presenting higher level notions, or historical content about the test cases, etc. Although not explicitely part of the project, it is expecteds to increase the attractivity of the site. Moreover, a selection of links to external sites will be added to some pages, provided their content seems reliable enough to comply with the UNIT philosophy.

6 Perspectives

The objective of this presentation is mainly to inform the scientific community about this initiative : this project intends to provide a free pedagogic content, obeying the ”Creative commons” licence. It will be available to any teaching institution interested in it, but also open to any teacher willing to participate.

Although the project intends to provide resources in French language, the development tools and the site structure have been chosen so that a multilingual extension may be added at any time. This presentation is therefore also an invitation to colleagues from other countries, if this project is found usefull for them or their institution.

Last, many institutions and individuals already propose contents of great quality in their respective web sites. Even if their objectives may not be similar to ours, we would appreciate to get all possible advices or comments about this project. It is not intended to replace any existing lecture : the aim is much more to raise the interest of students for Acoustics, so that we have a chance to increase the number of future young scientists and engineers in our research fields.