

INSTRUMENTATION SYSTEMS: DEVELOPMENT OF AN INTERNET-BASED COURSE

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This paper outlines the development of a course on Instrumentation Systems, delivered over the Internet. This is a senior undergraduate course for students who plan to enter Western's graduate program in Audiology. Such students come from all regions of Canada, and few have access to such a course at their previous institution. In addition to permitting students from anywhere in the country to access the course, Internet courses can be offered throughout the year, releasing students from the restrictions of a seasonal schedule of classes, and allowing them to take the course at a time and location which is convenient for them. The initial investment in course development is substantial, being many times greater than that for a traditional lecture course. However, course delivery is relatively inexpensive.

Internet-based courses offer certain pedagogical advantages for courses relating to acoustics: 1) they make it easy to incorporate audio demonstrations into course modules; 2) they similarly facilitate the use of computer-based video and illustrations; 3) they permit interactive learning at a pace set by the student; and 4) they permit arbitrary branching by the student, so that course materials can, but need not be, studied in strict linear fashion, as with traditional text- or lecture-format presentation.

Given these advantages, it is not surprising that many institutions are pursuing web-based courses, some in a significant way. As just one example the California Virtual University Foundation is a cooperative effort among 95 State-funded institutions of higher education: The University of California, the California State University and the California Community College, plus Sun Microsystems, Cisco Systems, Pacific Bell and Oracle. The Virtual University already provides 1,600 courses that are available to students at any of these institutions. A similar cooperative effort is underway among the states of the Pacific Northwest.

Our Internet course in Instrumentation Systems is based on an existing course, which is taught in a traditional, 13-week, lecture/lab format to first-year Audiology students at Western. During 1997/98, all students in the class reported that they had both access to and knowledge of the Internet, giving some assurance that the Internet version of the course would have been accessible to them.

The course follows a course in Hearing Science (see Taylor, Jamieson & Cheesman, this volume), which introduces basic concepts in physical acoustics, plus basic anatomy, auditory physiology, and psychoacoustics. The Internet course has been developed as a series of modules, reflecting the topics covered in the current course, during approximately 39 hours of lectures and 26 hours of laboratories.

Each module includes: 1) a statement of learning objectives; 2) explanatory and descriptive hypertext; 3) visuals in the form of diagrams, digital photographs, digital video, and animations; 4) audio demonstrations; 5) worked examples; 6) assignments; 7) a self-test review quiz; 8) references and suggestions for further study, both web-based and traditional; 9) an Adobe-format copy of a required reading; and 10) an optional, advanced-study component.

The course focuses on the following topics:

- 1) Review of basic concepts introduced in hearing science course
- 2) Overview of instruments and measurement devices
- 3) Properties of sound
- 4) Amplitude and damping
- 5) Fundamentals of Electricity and circuits
- 6) Filters and distortion
- 7) Digital Signals
- 8) Variables in an Acoustic environment (ambient noise, reverberation, signal-to-noise ratio)
- 9) Acoustic calibration
- 10) Introduction to Impedance
- 11) Introduction to ABR
- 12) Audiometric equipment (audiometers, hearing aids, tympanometers, OAE systems, and ABR systems)

The module on *Digital Signals* will be discussed as a representative sample of the course materials. This module covers the topics: 1) digital signals vs analog signals; 2) the sampling theorem; 3) quantization; 4) Nyquist rate; 5) aliasing; 6) conversions between analog and digital signals; and 7) digital synthesis of signals. In addition to diagrams and illustrations of concepts, audio demonstrations of the effects of quantization have been included to allow students to play back the signals on demand, in order to hear and appreciate the differences between the signals. These audio examples used in the module were originally prepared for a computer-based teaching module (Jamieson & Cheesman, 1997) using the CSRE software system. The examples provided are of speech signals that have been quantized at 16 bits, 10 bits, 4 bits, and 1 bit.

The student assesses the intelligibility and perceived quality of the differently-quantized speech signals. Worked examples of calculations of the number of amplitude values for each level of quantization are provided and students are then given a series of questions to work on their own. The module includes a self test, with multiple choice questions and definitions of terms. It concludes with a list of links to other web sites (e.g., <http://www.comdis.wisc.edu/VCD202/CD202menu.html>), providing students with a starting point for further exploration and directing them to relevant on-line demonstrations. Each module also links to the course teaching assistant, to allow personal feedback on individual questions and concerns regarding the course material.

During the 1999 winter term, the web course is being offered as an in-house supplement to the normal lecture course at Western. Revisions based on student evaluations and instructor experiences will occur the following summer. The course is scheduled to be offered as a self-contained Internet course beginning with the Winter, 2000 term.

REFERENCES

Jamieson, D.G. and Cheesman, M.F. (1997) CSRE-based teaching modules for courses in speech and hearing sciences. London: Avaaz Innovations, Inc.

DEVELOPMENT OF AN INTERNET-BASED COURSE IN HEARING SCIENCE

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This paper outlines the development of a course on Hearing Science, delivered over the Internet. This is a senior undergraduate course for students who plan to enter Western's graduate program in Audiology. Such students come from all regions of Canada, and not all have access to such a course at their previous institution. In addition to permitting students from anywhere in the country to access the course, Internet courses can be offered throughout the year, releasing students from the restrictions of a seasonal schedule of classes, and allowing them to take the course at a time and location which is convenient for them. The initial investment in course development is substantial, being many times greater than that for a traditional lecture course. However, course delivery is relatively inexpensive.

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The course is designed to introduce students from a diverse range of backgrounds to basic topics in acoustics, sound generation and transmission, sound characterization for both clinical and scientific purposes, anatomy of the human auditory system, auditory physiology, and auditory sensation and perception. Students will also become familiar with current theories and research on hearing through selected readings. They will learn the influence hearing science has had on audiological practice and understand how the consideration of new information may help advance the field of Audiology.

The Internet course has been developed as a series of modules, reflecting the topics covered in the current course, during approximately 39 hours of lectures and 26 hours of laboratories.

Each module includes 1) a statement of learning objectives; 2) explanatory and descriptive hypertext; 3) visuals in the form of diagrams, digital photographs, digital video, and animations; 4) audio demonstrations; 5) worked examples; 6) assignments; 7) a self-test review quiz; 8) references and suggestions for further study, both web-based and traditional; 9) an Adobe-format copy of a required reading; and 10) an optional, advanced-study component.

The course includes 30 modules covering the following topics: 1) sound transmission in the ear; 2) sine waves; 3) sound fields and resonance; 4) scientific notation and logarithms; 5) decibels; 6) anatomy of the auditory system; 7) auditory physiology; 8) auditory sensitivity; 9) signal detection theory; 10) measurement of hearing; 11) loudness; 12) masking; 13) frequency selectivity; 14) temporal processing; 15) perception of speech; 16) binaural hearing and cross-channel processes; and 17) the effects of hearing impairment on auditory perception.

The modules on *the Anatomy and physiology of the ear* supplement diagrams with animations demonstrating the movement of key anatomical structures during sound transmission and transduction. Students are referred to relevant external sites for advanced study [e.g., 1,2]. Modules concerning sound waves provide animations and video and sound clips to demonstrate how sound generation and transmission. Because many of our students have a restricted scientific and mathematical background, modules have been developed to introduce or review such relevant concepts as scientific notation and logarithms; these modules feature worked examples and make use of hypertext links to explain the derivation of equations and provide additional details useful in solving various fundamental problem types. Following these modules, the topics of Decibels and Signal Detection Theory are introduced, using a similar approach. Modules on auditory perception include illustrations, animations, video clips, and audio examples to demonstrate the various psychoacoustical phenomena and hearing measurement procedures.

Internet-based courses offer certain obvious advantages: they remove course enrolment restrictions based on geography (location of the student), time (both university term and specific course scheduling), and physical space (size of the lecture hall). They facilitate interactive learning and the incorporation of animations, video and audio demonstrations into course materials. The selection of material for study is determined by the student, through pacing, branching and repetition, making it appropriate for use by students with different backgrounds and abilities. Unlike the traditional classroom setting, in which all members of the class necessarily follow the same, largely-predetermined and nearly-linear sequence, students at different levels can move through the course material at a rate and in a sequence that is most appropriate for them. Students can move quickly through the areas with which they are familiar, and spend more time on those topics that are more novel or difficult for them.

Creation of the course has been extremely time consuming, even though it was derived from an existing course, which was highly developed and had many resource materials. In general, more than 80 hours of development time has been required for the initial implementation of each module, with much more time required for those modules where media materials were unavailable.

During the 1998 fall term, the web course in Hearing Sciences is being offered as an in-house supplement to the normal lecture course at Western. Revisions based on student evaluations and instructor experiences will occur over the following winter and summer terms. The course is scheduled to be offered as a self-contained Internet course beginning with the Fall, 1999 term.

REFERENCES

- [1] <http://ctl.augie.edu/perry/ear/heardis.htm>
- [2] <http://www.comdis.wisc.edu/VCD202/CD202menu.html>