Session 2aED

Education in Acoustics: Demonstrations and Tools in Acoustics Education

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Chair's Introduction—9:00

After the Chair's Introduction, the authors of each paper will briefly describe their demonstrations (2 minutes each). Authors will then be at their demonstrations to interact with interested participants for the remainder of the session.

Invited Papers

2aED1. Visualization of acoustic resonance phenomena using Kundt's dust figure method. Shinichi Sakamoto, Takumi Asakura, Kanako Ueno (Inst. of Industrial Sci. Univ. of Tokyo, Komaba 4-6-1, Meguro-ku, Tokyo, 153-8505, Japan, sakamo@iis.u-tokyo.ac.jp), Yu Sakimoto, Fumiaki Satoh, and Hideki Tachibana (Chiba Inst. of Technol., Narashino-shi, Chiba, 275-0016, Japan)

It is very effective to visualize a sound field for intuitive understanding of various acoustic phenomena, especially for acoustic education. The most famous and classical visualization technique is the Kundt's dust-tube method contrived by August Adolph Kundt. He devised this experimental technique to determine the sound velocity in the air by observing the mode pattern of a standing wave excited in a glass tube. The technique can be applied to various other acoustic resonance phenomena. In Japan, Sato and Koyasu applied this technique to a two-dimensional room acoustic model experiment in which the effect of the shape of a reverberation room on the normal modes was examined. Referring to these experiments, the authors made experimental equipment to visualize acoustic resonance phenomena for an educational purpose. In our experiment, two types of two-dimensional boxes with hard surface were prepared. In these boxes, normal modes in a closed sound field and the Helmholtz resonance phenomena, which are essential and important for architectural acoustics, can be visualized. These physical experiments are visually impressive on students in architectural courses and therefore the experiment is efficiently used in architectural acoustic courses.

2aED2. Animations of different sound field decomposition methods. U. Peter Svensson and Bård Støfringsdal (Acoust. Group, Dept. of Electron. and Telecommunications, Norwegian Univ. of Sci. and Technol., NO-7491 Trondheim, Norway, svensson@iet.ntnu.no)

Many methods for solving sound-wave propagation problems are based on a decomposition of the sound field. Here, several such decomposition methods will be demonstrated and it will be illustrated how they can give the same final solution even if the partial solutions, or the solutions outside a limited domain, can be very different. Animations of harmonic and transient solutions will be used to illustrate sound-field synthesis based on a decomposition into plane waves, cylindrical harmonics, and geometrical acoustics plus edge-diffraction components. It will also be shown how a sound field that is measured in discrete points can be converted to different representations. These decompositions have pedagogical merits but can also be used in sound-field reproduction techniques. Examples will include free-field situations as well as indoor cases with a multitude of reflections. [This research was supported by the Research Council of Norway.]

2aED3. Introduction of sound material in living environment 2004 (SMILE 2004): A sound source database for educational and practical purposes. Keiji Kawai (Grad. School of Sci. and Technol., Kumamoto Univ. 2-39-1 Kurokami Kumamoto 860-8555, Japan, kawai@arch.kumamoto-u.ac.jp), Kazutoshi Fujimoto (Kyushu Univ.), Teruo Iwase (Niigata Univ.), Tetsuya Sakuma (The Univ. of Tokyo), Yoshito Hidaka (Tohwa Univ.), and Hirohito Yasuoka (The Ctr. for Better Living)

Sound sources are used in various settings of education, research, and business that are related to architectural acoustics. Especially in educational scenarios, they are very effective for students to learn theories together with the experience of listening to actual sounds related to them. Sound Material In Living Environment (SMILE 2004), a sound source database published in 2004 in DVD form (Japanese only), is the culmination of our project. SMILE 2004 is intended as a collection of sample sounds for use in lectures on architectural acoustics at universities or industrial high schools. In addition, it is useful for measurements or demonstrations for academic or practical purposes. The database contains 913 digital sound files of real sounds and impulse responses, which cover the

aesthetics of answers to given base tasks. [Work partly supported by Grant-in-Aid for Scientific Research (No. 16700154), MEXT, by High-tech Research Center promoted by Ryukoku University, by Academic Frontier Project promoted by Doshisha University, and by Knowledge Cluster Project promoted by MEXT, Japan.]

2aED8. Acoustic demonstrations for education in speech science. Takayuki Arai (Arai Lab., Dept. of Elec. and Electron. Eng., Sophia Univ., 7-1 Kioi-cho, Chiyoda-ku, Tokyo, 102-8554 Japan)

Acoustic demonstrations are highly effective for education in speech science. We recently developed two educational tools for acoustics. The first educational tool is a set of physical models of the human vocal tract and related models. It contains cylinder and plate-type models [T. Arai, J. Phonetic Soc. Jpn., **5**(2), 31–38 (2001)], a sliding three-tube model [T. Arai, Acoust. Sci. Technol., to be published], lung models, an artificial larynx, and head-shaped models [T. Arai, Acoust. Sci. Technol., **27**(2), 111–113 (2006)]. Each model has its own advantages and, if combined effectively, can produce a systematic and comprehensive education in speech production from the lungs to the head. The second educational tool is ''Digital Pattern Playback (DPP)'' [T. Arai *et al.*, Acoust. Sci. Tech., to be published], which converts a spectrographic image of a speech signal back to sound by digital signal processing. A printed spectrogram on a sheet of paper can also be converted immediately after capturing the image from a camera, and we confirmed that this is more intuitive for learners than converting from an electronic image. [Work partially supported by JSPS.KAKENHI (17500603).]

2aED9. Tools for speech perception, production, and training studies: Web-based second language training system, and a speech resynthesis system. Reiko Akahane-Yamada, Takahiro Adachi (ATR, 2-2-2, Hikaridai, Seika-cho, Soraku-gun, Kyoto, 619-0288 Japan), and Hideki Kawahara (Faculty of Systems Eng., Wakayama Univ. 930 Sakaedani, Wakayama, 640-8510 Japan)

We describe a Web-based instruction system for second language (L2) learners, dubbed ATR CALL. This system is a collection of speech perception, production, and comprehension training tools, designed to examine L2 acquisition mechanisms, especially for native speakers of Japanese who are learning English as L2. Each training component focuses on the acoustic-phonetic, prosodic, lexical, or semantic decoding level of spoken language. The stimuli are selected and presented from a large speech database of 13 000 English words and 6000 English sentences. In the pronunciation training component, learners' productions are scored using HMM-based evaluation algorithms, and automatic and immediate feedback about pronunciation goodness is provided. Speech analysis tools for language learners are also provided. We also describe a speech manipulation system, dubbed STRAIGHT [Kawahara *et al.*, Speech Commun. (1999)]. This system resynthesizes stimuli with quality as high as the original stimulus even after manipulating multiple parameters. A speech morphing algorithm on this system enables us to manipulate various features independently [Kawahara *et al.*, ICCASP 2003]. Thus, it generates stimulus continuum varying in supra-segmental domain and/or segmental domain. [Work supported by JSPS, and e-Society by MEXT.]

2aED10. Vowel synthesis tool based on transmission line model as a web application. Kohichi Ogata, Takuro Masuya, and Yuichiro Shin (Grad. School of Sci. and Technol., Kumamoto Univ., 2-39-1 Kurokami Kumamoto 860-8555, Japan, ogata@cs.kumamoto-u.ac.jp)

This paper introduces a web application for vowel synthesis in acoustics education. Synthesis systems that provide users with interactive operation for determining vocal tract configuration and vocal fold control parameters can be effective tools for intuitive understanding of vowel production for students. For example, differences in the size of the vocal tract and vocal folds between male and female speakers can be recognized as differences in formant and pitch frequencies in speech sounds. The realization of such a system as a web application is suitable for platform independent use, considering the recent progress in information and communication technology. In our developed system, interactive operation for determining vocal tract configuration and vocal fold control parameters is achieved on a web browser by using a Java applet. These articulatory parameters are transferred to a server computer via a client/server connection using socket programming, and synthetic speech is produced using calculation programs on the server computer. The speech synthesizer installed on the server is based on the hybrid speech production model proposed by Sondhi and Schroeter. A preliminary user test showed that the system demonstrated a certain applicability as a teaching tool.

2aED11. WWW-based multilingualized system for technical listening training. Akira Nishimura (Dept. of Media and Cultural Studies, Tokyo Univ. of Information Sci., 1200-2, Yato-cho, Wakaba-ku, Chiba, Japan)

A WWW-based system for technical listening training is proposed. Messages from the system shown in a WWW browser are multilingualized using the GNU gettext mechanism. A system administrator can easily set up the system in a user's language by translating the message catalog. The WWW-based training system is superior to previous training systems in the following respects: (1) software and hardware can be organized more easily; (2) modification and creation of the contents of training are simple; (3) individual training parameters can be set for users; (4) many users can use the system individually or simultaneously; (5) the results of training for users are saved and summed individually; and (6) difficulty of discrimination training is automatically set up individually. Training experiments of intensity discrimination and frequency discrimination were performed using a prototype of the training system for subjects who were naive to auditory experiments. Significant improvements in the abilities of both intensity and frequency