Education in Acoustics Using the Multimedia Presentation Style

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ABSTRACT
The present report describes a method of acoustic science education using the multimedia-presentation style. The results of an evaluation of subjects who attended this style of class have been obtained and are satisfactory. Further analyses have been scheduled in order to provide a more detailed evaluation of the present method and to develop applications for higher education.

1. INTRODUCTION

Students of acoustic science often experience great difficulty in understanding phenomena such as sound waves, because these phenomena are invisible. Recently, the combination of faster computers having larger hard disks and powerful presentation software packages that use a graphical user interface has made possible real-time multimedia presentations in the classroom to demonstrate acoustic phenomena which require complex computer-aided calculation. We have created a multimedia teaching material system for acoustic science which includes a number of movies and simulation programs. These multimedia teaching materials have been used to present classes in acoustic science to juniors at our university. The average degree of overall satisfaction as reported by the students of those who attended this type of class is radically higher in comparison to conventional lectures using the blackboard. In addition, end-of-term test results have improved of the statement type.

2. MULTIMEDIA TEACHING MATERIALS

The teaching materials used for acoustic engineering are arranged in nine sections. More than 10 main slides, several simulation programs and a number of movies are used in each section, as shown in Fig.1.

Index	Simulation programs		Movies & sounds		Main files of presentation
1.Introduction	3	· Wave growth · D.F.T · Alias wave	2	· International Conference on Computer in Education	16
2.Propagation of sound	4	· Wave equation · Waves in solid · Horn · Earthquake	1	· Structure of silencers	15
3.Vibration & radiant	7	· String · Sound field of disc front · Disc · Characteristics of disc · Double source · Charact. of line source · Spherical wave	3	· Bari International Percussion Festival 1999 · Playing Japanese string instrument "Shamisen"	12
4.Reflection of wave	3	· Reflection of wave · Resonance in a tube · Resonance in a box	2	· Samarkand International Music Festival 1999	16
5.Electronic sound	1	· Field of stereo sound	0		20
6.Caricature of ultrasonic	2	· Refraction · Diffraction	1	· Cracking with ultra-sonic	17
7.Using ultrasonic	1	· Cavitation	0		16
8.Voice signal processing	3	· Spectrum · Liner prediction · Formant	4	· Mongolian throat singing · Movement of vocal chords	11
9.Auditory sense	8	· Dram spectrum · Basilar menbrance · Masking · Critical band · Color blinker · Chord · Consonance · Synthesis	5	· Engel Fall in Venezuela · Playing of various musical instruments	15

Fig. 1 Multimedia teaching materials for acoustic science

Each of the above slides uses animation. Several slides have explanation buttons linking them to simulation programs, supplementary slides, movies, or sounds. Figure . shows an example of the presentation structure, in which the theory of string vibration is explained in the main slide. If necessary, the focus of the presentation can be changed by switching from a main slide to some supplementary slides. In the case shown in Fig. 2, doing so changes the numerical formulae presented to the students. In the supplementary slide, a different set of equations is presented. In addition, the presentation can include a simulation program which describes dynamically various phenomena of fixed edge string vibration. In this program, the initial position of the string can be chosen as either a delta wave or a sine wave.

Parameters such as air viscosity can be varied by changing the position of the slider. MPEG movies, photographs and sound files are prepared in order to help students better understand the theory. For this subject, short movies showing the playing of stringed instruments are used to help describe string vibration.

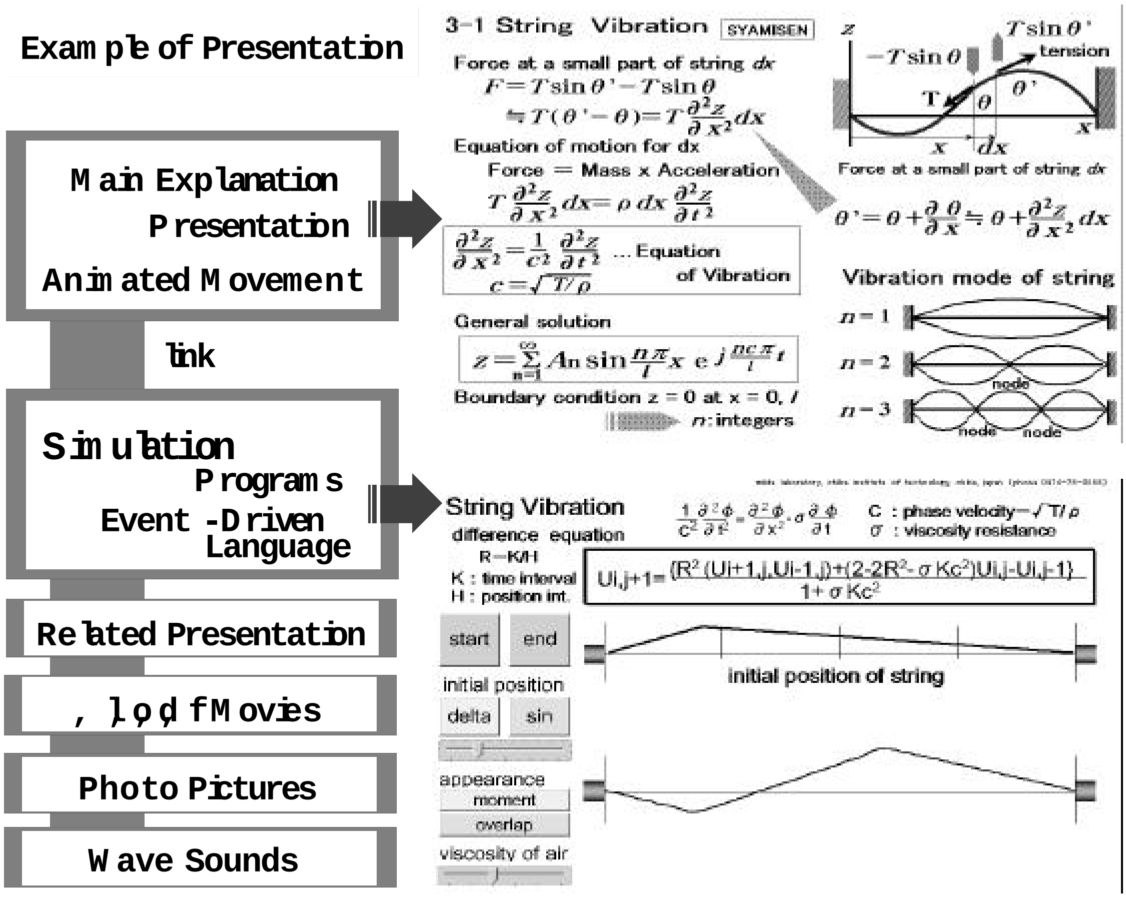

Fig. . Presentation structure for string vibration

An example presentation of the discussion of directional distribution of sound pressure from a vibrating disc is presented next. The main slide is shown in the left-hand side of Fig... The theoretical formula of the directional distribution is written at the top of this slide. Example calculation results for ka = 10 are displayed in the lower part of the figure. However, because the theoretical formula contains numerous parameters, a thorough understanding of the concept is difficult to obtain when presented with this single description. In addition, since the calculation results are presented via the plane method, understanding the results is not intuitive.

One example of the result of linking this simulation program and the main slide is shown in the right-hand side of Fig. 3. The calculation result of produced using the theoretical formula can be written three-dimensionally in real-time by arbitrarily specifying parameters using slide buttons on the screen. Understanding this phenomenon is easy because the solid figure produced using the calculation results rotates continuously.

The next example, resonance phenomena in a thin rectangular box, is shown in Fig.4. The main slide in the left of this figure explains the progressing theoretical formula.

The picture on the right shows one example of a simulation program linked to a main slide. Real-time movement of gas particles of various resonance modes inside the rectangular box can be observed using this program.

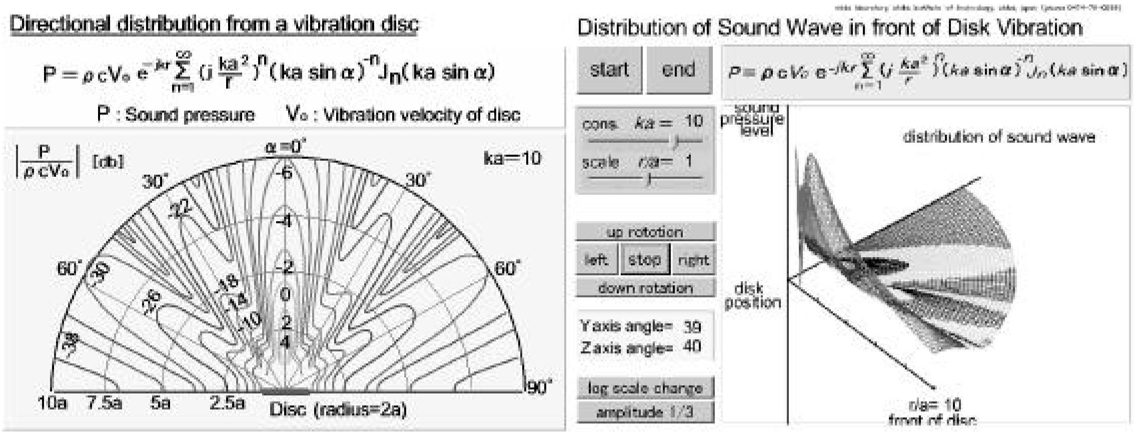

Fig. 3 Slide explaining directional distribution of sound pressure in a vibrating disc and a picture produced using the simulation program

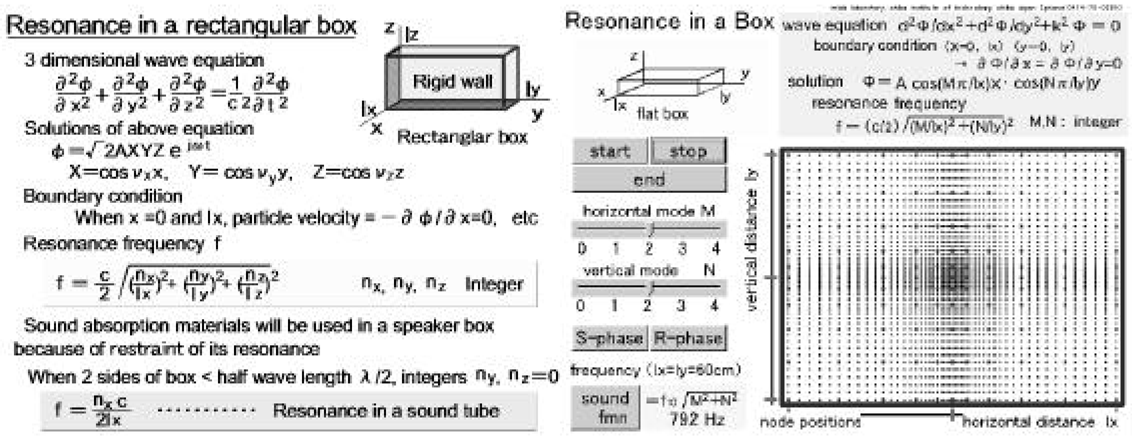

Fig. 4 Slide explaining resonance in a rectangular box and a picture produced using the simulation program

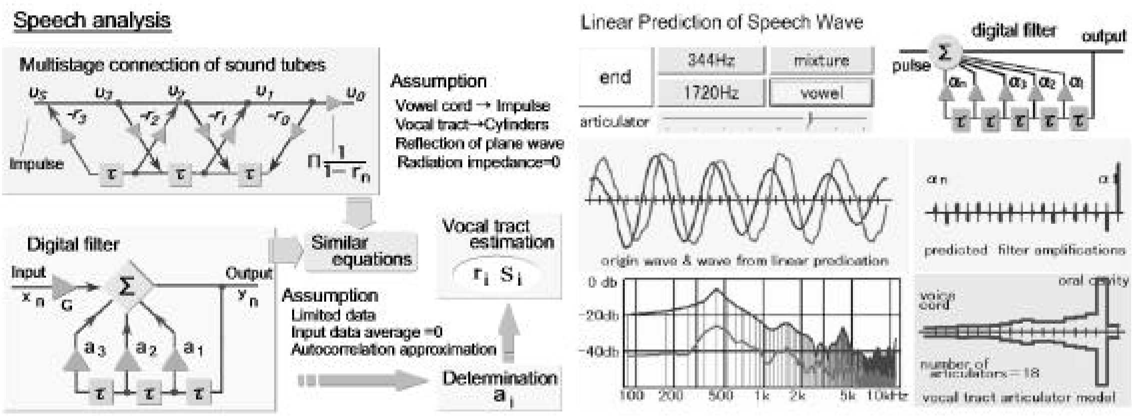

Fig. 5 Slide explaining speech analysis and a picture produced using the simulation program

The main slide for the presentation explaining voice analysis and an example showing a simulation program linked to this slide are shown in Fig.5. Using this program, the DFT processing for an arbitrary vowel is given, and the frequency spectrum of this vowel is displayed immediately. Linear prediction analysis is performed for the vowel data, and the shape of the vocal tract is calculated. Finally, the sound can be heard using a synthetic voice created using these calculation results.

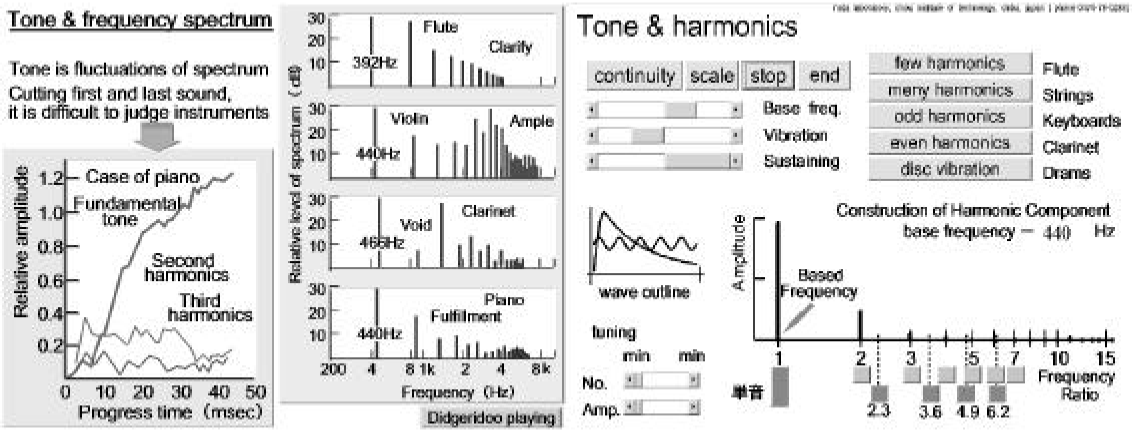

Fig. . Slide explaining tone and a picture of the simulation program

Another example presentation is an explanation of the theory of tone and harmonics of musical instruments. Here, the main slide, shown in Fig.6, suggests that the tone of a musical instrument depends on its frequency spectrum.

A program to create sounds can be derived from this main slide. The screen shown on the right-hand side of the figure will appear when the simulation program is running. The sound of a feature tone is produced by selecting one of the buttons at the upper-right corner of this screen. The amplitudes of harmonics for each sound appear at the lower-right corner of the screen.

In contrast, harmonics are not generated by the vibration of a disc because the vibration mode becomes two-dimensional. An attenuation and vibration effect can be assigned to a created sound, hence changing the positions of parameter indicators on the screen.

3. THE MULTIMEDIA CLASS

The class in the present report is structured for a 15-week course in half year, and is intended for approximately 130 students. The textbook is used for reference, and the presentation contents are distributed to students in the form of full color prints. The class is presented in a multipurpose classroom containing 150 workstations, LCD projectors and eight screens. The brightness of the projector is over 2,000 [lumens], and the content of the personal computers can be projected onto these screens. These workstations are connected through a gigabit network. Some examples of main slides connected to situational programs are shown in Figs.3-..

We have educated acoustic engineers using the conventional blackboard and textbook method for 15 years. This changed four years ago when we began using multimedia presentations. Figure. shows the effect on test scores of acoustic education using the present multimedia system. Before the present multimedia system was used, students tended to ask questions concerning various forms of the numerical formulae. After this multimedia system was put into use, students began to ask more questions concerning phenomena in doubt.

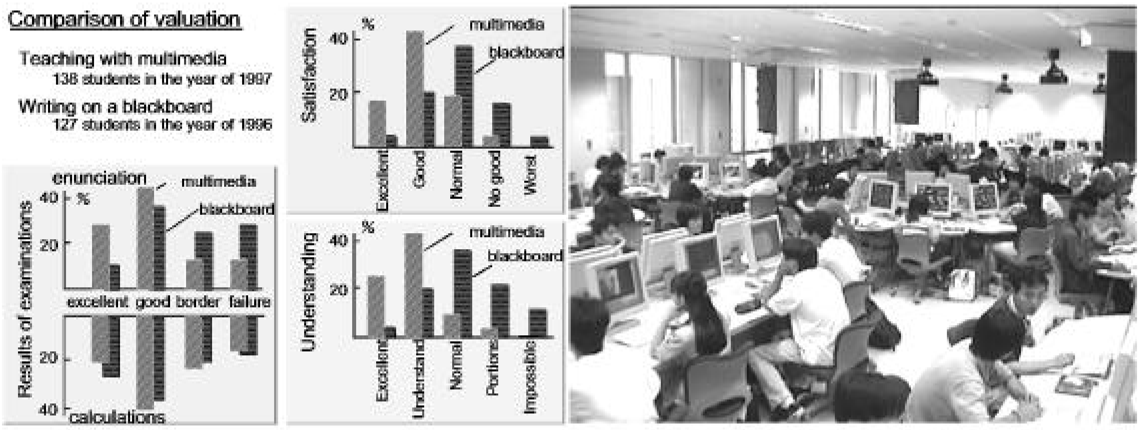

Fig. . Results of teaching using the multimedia presentation style versus those for the conventional teaching style and a photograph of a multimedia presentation style classroom

4. CONCLUSION

The present report describes the techniques of using animation characters, sounds, and simulation programs as teaching materials in the field of acoustic engineering, which provides multilateral education experience. Acoustic science education through multimedia presentation was achieved, and satisfactory results were obtained in tests used to evaluate students attending this class. More detailed analyses are scheduled to be performed in an attempt to develop a method for use in higher education and to improve the overall effectiveness of the education. In the future, we hope to develop similar systems for other fields of study.

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