A New Audio Testing Method with Document Structure Tables for the Dyslexic and the Newly Blind

Mamoru Fujiyoshi[1], Akio Fujiyoshi[2], and Toshiaki Aomatsu[3]

[1] Research Division, the National Center for University Entrance Examinations
2-19-23 Komaba, Meguro, Tokyo, 153-8501, Japan
fujiyosi@rd.dnc.ac.jp

[2] Department of Computer and Information Sciences, Ibaraki University
4-12-1 Nakanarusawa, Hitachi, Ibaraki, 316-8511, Japan
fujiyosi@mx.ibaraki.ac.jp

[3] National School for the Blind of Tsukuba University
3-27-6 Mejirodai, Bunkyo-ku, Tokyo, 112-8684, Japan
aomatsu@nsfb.tsukuba.ac.jp

Abstract

A new audio testing method with document structure tables was developed for the dyslexic and the newly blind, who have difficulties with reading in braille or print. Since documents in the National Center Test for University Admissions are very long and have very complicated document structure, we needed to develop a new audio testing method for the National Center Test. The new audio tests can be administrated only with a digital audio player with 2-dimensional code reader and sheets of paper on which document structure tables and corresponding invisible 2-dimensional code have been printed.

1 Introduction

It has been difficult for the dyslexic and the newly blind, who have difficulties with reading in braille or print, to take the National Center Test for University Admissions since audio tests have not been administrated yet. The National Center Test is the joint achievement test for admissions into all national and local public universities as well as many private universities in Japan. Every year, about 550,000 students take the National Center Test. As for test-takers with disabilities, special arrangements regarding test media such as large print test and braille-format test have been administered [6]. There are difficulties in administrating ordinary types of audio tests for the National Center Test because the documents are very long and the document structure very complicated. This study introduces a new audio testing method for the dyslexic and the newly blind.

Ordinarily, audio tests are administrated by means of readers [4], audio cassettes [2, 7, 8] or computers [1]. The simplest procedure is to recruit readers and have them read out a test booklet to a test-taker directly, but it is not easy to find enough well-trained readers for each test-taker. And for fairness and security reason, it might be necessary to supervise such readers by another person. Audio cassettes make it easy for test-takers to listen to the test sequentially, but it is inconvenient to go directly to a particular section of the test unless rewinding and fast-forwarding can be done easily. A computer test is also inappropriate for tests written in Japanese even with advanced screen-reader software for the blind because of the ambiguity of the reading of Kanji in Japanese sentences. Screen-reader software can not always convert Japanese sentences into correct Japanese speech.

For audio tests for the National Center Test, the utilization of DAISY (Digital Audio Accessible Information System) [**?** **?**] and Table PC [5] has been studied. DAISY [3] is a

Figure 1: An image of administration of the new audio testing method

world standard audio system for people with visual disabilities, taking the place of audio cassettes. DAISY offers audio tests in CD quality, and test-takers can listen to the test from any point, such as from an underlined or blank part, without delay. They can also use the talk-speed-control function, by which the speech sound can be adjusted from 1/2 to 3 times normal speed. However, DAISY is not convenient enough for tests which have complicated document structure. Tablet PC has been identified as appropriate test media for audio tests [5]. However, there are difficulties in administration because prevention of machine trouble cannot be ensured.

We developed a new audio testing method with document structure tables. In Fig. 1, an image of administration of the new audio testing method is shown. The new audio tests can be administrated only with a digital audio player with 2-dimensional code reader and sheets of paper on which document structure tables and corresponding invisible 2-dimensional code have been printed. For the dyslexic, the document structure tables are printed as ordinary layout characters, while, for the newly blind, they are printed as braille layout characters.

This paper is organized as follows: Section 2 contains a summary of the method; Section 3 provides an experimental evaluation; and Section 4 is the conclusion.

2 The New Audio Testing Method

The new audio tests can be administrated only with a digital audio player and sheets of document structure tables. An invisible 2-dimensional code system and a digital audio player with 2-dimensional code reader enable us to develop the new audio testing method.

2.1 Document Structure Tables

Document structure tables are sheets of paper on which the document structure of each problem is illustrated. The document structure and corresponding invisible 2-dimensional

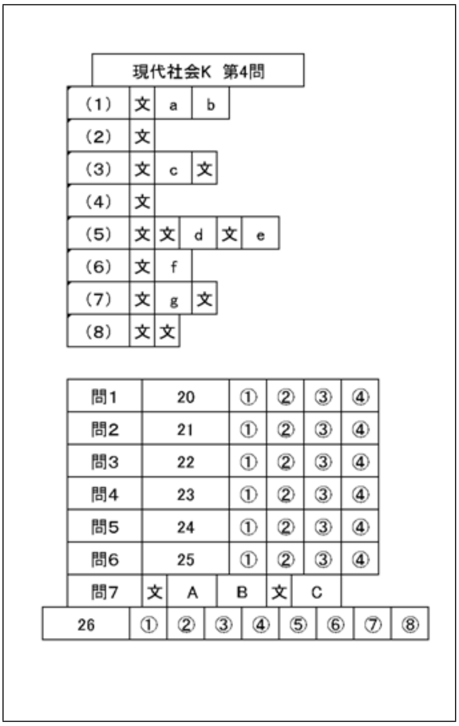

Figure 2: An example of the document structure table printed on a paper

codes are printed on a white paper by an LED printer (OKI Data Corporation). For the newly blind, the braille document structure is also embossed overlappingly on the paper by a braille printer (ESA721; JTR Corporation).

Fig. 2 is an example of a document structure table. Each document structure table of a problem can be arranged within a sheet of paper. In Fig. 2, the first line shows the subject name 'Gen-Dai Sha-Kai K' and the problem number 'Dai 4 Mon'. The upper part shows the document structure of the theme document of the problem. Each line '(1)'-'(8)' corresponds to a paragraph in the theme document. The symbol 'Bun' represents a sentence in a paragraph, and the symbols 'a'-'g' represent underlined parts of the theme document. The lower part shows the document structure of the questions of the problem. Each line 'Toi 1'-'Toi 7' corresponds to a question. The numbers '20'-'26' represent answer items, and the circled symbols '1'-'8' represent multiple-choice answers for an answer item.

On the same paper of a document structure table, invisible 2-dimensional codes can be printed overlappingly. For an evaluation experiment, we employ 'GridOnput', an invisible 2-dimensional code system developed by Gridmark Solutions Co.,Ltd. Fig. 3 is an image of dot pattern of GridOnput. Dots are arranged at intervals of about 0.25mm. The size of a code is about 2mm square.

2.2 IC Player with 2-Dimensional Code Reader

As a reading device for the new audio testing method, we employ 'Speaking Pen' developed by Gridmark Solutions Co.,Ltd. Speaking Pen has a 2-dimensional code reader at its top.

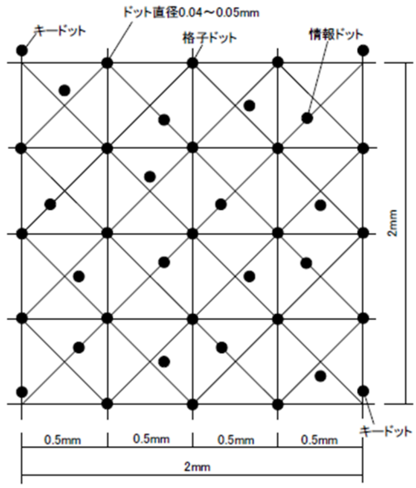

Figure 3: An image of dot pattern of GridOnput

When a 2-dimensional code is scanned with Speaking Pen, the corresponding digital sound will be reproduced. We can listen the sound through a headphone or built-in speaker. The sound volume can be adjusted with its buttons mounted at the front side. The sound data is stored in a SD memory card. 1G byte is enough to store all sound data of 1-year amount of the National Center Test.

3 Evaluation Experiment

In order to evaluate the new audio testing method, an experiment was conducted by comparing the new audio test with three different speaking speeds and the braille-format test.

3.1 Method

The experimental design was a repeated 4x4 Graeco-Latin square method because we could not use the same problem in different test media for the same person. The image of the experimental design for the Graeco-Latin square method is shown on Table 1. The subjects are 16 students from a high school for the blind (some are graduates of a high school for the blind), who are familiar with both braille and audio learning materials. There were 4 subject groups, i.e., the subjects were evenly divided into 4 subgroups. There were 4 test media: the braille-format test, the audio test of normal ($\times 1.0$) speaking speed, the audio test of $\times 1.5$ speaking speed, and the audio test of $\times 2.0$ speaking speed.

Four problems were prepared from tests in 'Contemporary Social Studies' previously used in the National Center Test. The allotment of marks, number of characters, and number of braille cells are shown on Table 2.

The test procedure is administered without time limits. The answers are written in braille. The behavior of subjects is observed by test monitors, and the answer-process time of subjects was recorded by the monitors using stop watches.

Table 1: Image of the experimental design for the Graeco-Latin square method

		Subect Groups			
		Group 1	Group 2	Group 3	Group 4
Order	1	Braille Problem 1	Audio $\times 1.0$ Problem 3	Audio $\times 1.5$ Problem 4	Audio $\times 2.0$ Problem 2
	2	Audio $\times 1.0$ Problem 2	Braille Problem 4	Audio $\times 2.0$ Problem 3	Audio $\times 1.5$ Problem 1
	3	Audio $\times 1.5$ Problem 3	Audio $\times 2.0$ Problem 1	Braille Problem 2	Audio $\times 1.0$ Problem 4
	4	Audio $\times 2.0$ Problem 4	Audio $\times 1.5$ Problem 2	Audio $\times 1.0$ Problem 1	Braille Problem 3

Table 2: Allotment of marks, number of characters, and number of braille cells

	Marks	Characters	Braille Cells
Problem 1	5	2,255	4,866
Problem 2	5	2,000	4,543
Problem 3	5	1,796	3,996
Problem 4	5	2,410	5,247
Total	20	8,461	26,190

3.2 Result

The score distributions of the four test media were almost same. There were no significant difference among the braille-format test, the audio test of normal speaking speed and the audio test of $\times 2.0$ speaking speed. However, the score of the audio test of $\times 1.5$ speaking speed was significantly lower than the other test media. The Box-and-whiskers plots in Fig. 4 represent the score distribution of each test media. The vertical lines in the middle of the box plots indicate the median. The '+' symbols in the boxes are the mean.

The distribution of the answering speed of the four test media were also almost same. The answering speed of the audio tests of $\times 2.0$ and $\times 1.5$ speaking speed was a little faster than the braille-format test but there were no significant difference. Indeed, there was a significant difference between the answering speed of the braille-format test and the audio tests of normal speaking speed. However, the difference was only 2% in median between them. The Box-and-whiskers plots in Fig. 4 represent the distribution of the answering speed of each test media.

We found that the answering speed becomes 10% or 13% faster if the audio test of $\times 1.5$ or $\times 2.0$ speaking speed is used comparing to the normal speaking speed.

4 Conclusion

The new audio testing method with document structure tables enables the dyslexic and the newly blind to take the National Center Test for University Admissions since the administration of the new audio test is easy and test-takers can handle problems with complicated document structure. We can administrate the new audio test only with a digital audio player with 2-dimensional code reader and sheets of paper on which document structure tables and corresponding invisible 2-dimensional code have been printed, and test-takers

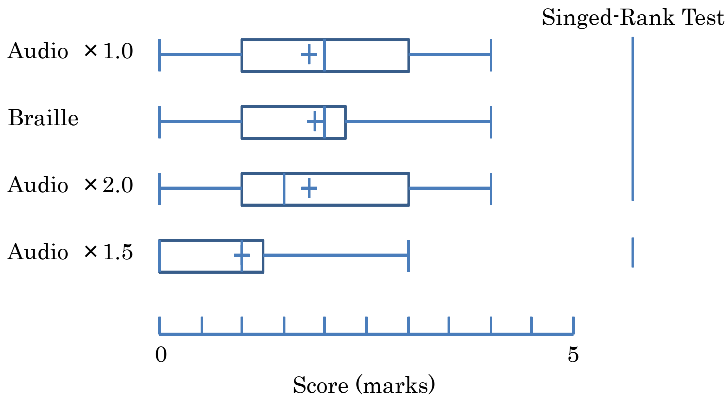

Figure 4: Box-and-whisker plots for the score

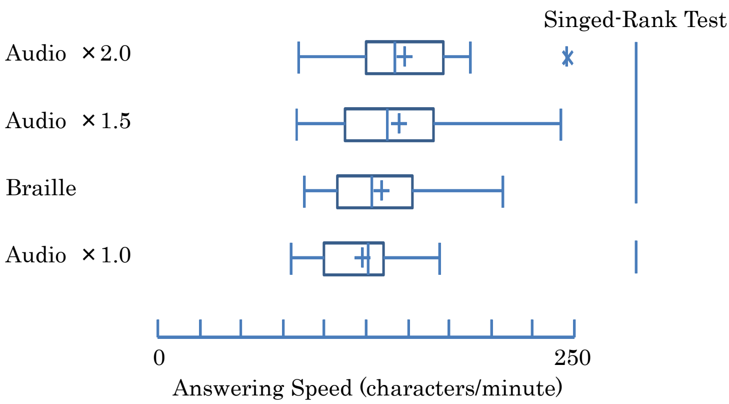

Figure 5: Box-and-whisker plots for the answering speed

can start reading problems and questions at any point of their preference. If we print 2-dimensional codes on figures, we can set problems with figures.

As a result of evaluation experiment, the new audio test is almost equivalent to braille-format test in score and answering speed.

References and Notes

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