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e-Learning Program with Voice Assistance for a Tactile Braille

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***Abstract*—**Along with the increased morbidity of glaucoma or diabetic retinitis pigmentosa, etc., number of people with vision loss is also increasing in Japan. It is difficult for the visually impaired to learn and acquire braille because most of them are middle-aged. In addition, number of braille teachers are not sufficient and reducing in Japan, and this situation makes more difficult for the visually impaired. Therefore, we research and develop a Web-based e-learning program for tactile braille, that cooperate with braille display and voice assistance.

***Keywords*—**Acquired visually impaired, Braille, e-learning, Tactile braille

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I. Introduction

BRAILLE is a reading and writing system for the blind and the partially sighted that consisits of six tactile raised dots. It was invented by a blind Frenchman, Louis Braille, in 1825 [1]. In Japan, Kuraji Ishikawa, a teacher at a school for the blind and speech-impaired in Tokyo, adapted the braille alphabet to Japanese in 1890. Japanese braille is different from English braille in use of indicators to express voiced sounds, long vowels or special sounds, unlike the basic 50 sounds, and in use of text segmentation named *Wakachigaki* [2], like spacing between words in English and European languages. Later in 1901, the braille of Ishikawa was introduced as "Japanese braille for the blind" in the official gazettes in Japan. Braille is a basis of education at schools for the visually impaired [3] and a means of gaining information in print for them. Regarding the accessibility of blind and partially sighted patients to medical information, Japan's Ministry of Welfare issued instructions to Regional Medical Affairs Office on the patient compliance instructions for the disabled including the blind (No. 289, Ministry of Health and Welfare, Healthcare Service Bureau, 19th of August, 1998) and Central Social Insurance Medical Council issued the revision in the fiscal year 2000 of remuneration for medical services (Ministry of Health and Welfare, Medical Economics Division, Health Insurance Bureau, 29th of February, 2000). The former encouraged medical institutions to provide drug administration in Braille on medical envelopes and the latter is to cover providing medical information in Braille by Central Social Insurance. Considering this situation that the provision of information in braille is being required, it is very important for the visually impaired to acquire braille [4]. We have developed braille translation engine named KUIC which follows the latest Japanese braille transcription rules 2001 [2] to implement on our program and provided open access to automatic braille translation program "eBraille" or "eBraille-M." [5] We also have started providing medical information in braille by using our program and are preparing such system in our hospital [5]. Braille acquisition is considered to be necessary for the blind and the visually impaired in order to avoid the social disadvantages in information disparity.In the recent years, the number of people with acquired vision loss is more increasing, because of glaucoma, diabetic retinitis pigmentosa, etc., than people with congenital visual impairment. People with acquired vision loss have to change the letters for communication to braille from what they used to use, that is, letters for the sighted. It is difficult, however, to learn braille and so many of them give up learning and depend on their residual vision, or change to sound media such as tape recorder. As a result, literacy rate of braille became lower and it lead to 12.7% for all the blind and visually impaired people in Japan.To make an increase for the low rate Braille literacy in the people with acquired vision loss, we have researched and developed a self- and e-learning program for tactile Braille with a personal computer. This paper reports our research development and our analysis whether our program is effective or not to the visually impaired for braille learning.

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II. Methods

A. Evaluation for the Visually Discrimination of Diagram

First we examined that the most discriminative diagram for the visually impaired, as the raised dot of braille. This experiment was conducted from 2009 to 2011 in cooperation with 74 visually impaired students in the National Kobe Rehabilitation Center for the Visually Disabled: 60 males and 14 females. The number of each degree of the impairment which followed physical disability certificate in Japan was: 48 people in the second grade (total binocular vision if from 0.02 to 0.04 and the rate of visual dysfunction is over 95%), 12 for the third (total binocular vision if from 0.05 to 0.08 and the rate of visual

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dysfunction is over 90%), 7 for the fourth (total binocular vision if from 0.09 to 0.12), 7 for the fifth (total binocular vision if from 0.13 to 0.2). Their age covers from 18 to 62 and the average was 41.6±12.4.We used and compared five diagrams, "●" "▲" "■" "★" "+" for the raised dot, which were used in National Rehabilitation Center (Fig 1). We made the graphic braille with white background sufficiently large on the computer display (17inch, 1920×1200 pixel) in order to reduce the burden to the informants' eyes.

The evaluation for the diagram was as follows:

(1) Display five diagrams randomly ordered on the screen for 60 seconds.

(2) Each diagram is displayed for 10 seconds, one by one in another random order.

(3) Iterate (1) and (2)

(4) Display five diagrams randomly ordered on the screen for 60 seconds.

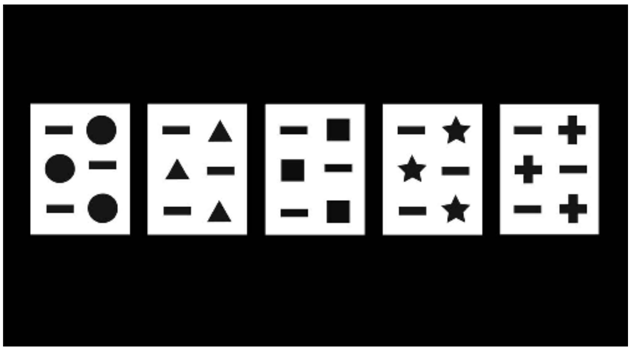

Fig. 1 Graphic braille samples with five diagrams

```
function nxt(path){
  var i=questions.length;
  var next_q=Math.floor( Math.random() * i );
  if(questions[next_q] == 0){ next_q = Math.random() * i; }

  if(path != ""){
    location.href= path + "/q/q" + questions[next_q] + ".html";
  }else{
    location.href="./q/q" + questions[next_q] + ".html";
  }
}
```

Fig. 2 Automatic selection for the question by JavaScript program

During this session, informants were seated and watched the diagrams. When the session was over, they scored each diagram with the range from the point 1 to 5. We calculated the scores and statistically analyzed by using GraphPad PRISM software (GraphPad Software, Inc., La Jolla, CA, USA). We then used the diagram with the highest score for the raised dot.

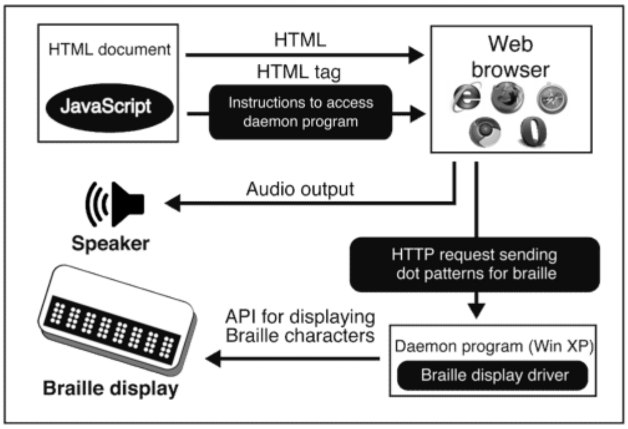

Fig. 3 Our web-based e-learning controlling braille display

```
function BMSendMessage(q){
  document.write("<img src='http://127.0.0.1:1800/" +
    q + "' style='width: 1px; height: 1px;position: absolute' />");
}
```

Fig. 4 JavaScript program in HTML for operating Braille display

B. Development of the e-Learning Program with Voice Assistance for Tactile Braille

We constructed a Web-based e-learning program for braille so that the program is independent of computer architecture or OS. This e-learning undergoes the three steps: (1) the question for users is selected randomly and displayed with options for answer on the screen, (2) users select the answer (3) scoring by the program. The selection of the questions in step (1) was implemented with Math.random function of JavaScript embedded in HTML file (Fig 2). Our e-learning consisted of JavaScript, Web browser, braille display driver program and braille display (Fig 3). We embedded the files with recorded human voice into HTML files as the voice assistance (Fig 3). Braille display cooperates with the HTML files in our e-learning as follows: First, Web browser program requires HTTP access from the driver (daemon) program by JavaScript in HTML tags. Then this request is sent to the port of the daemon. The braille display driver send this HTTP request to USB port of the braille display. Lastly, braille is displayed on the braille display.

Each graphic braille for our e-learning were created by Adobe Illustrator and then converted into JPEG file by Adobe Photoshop in 300dpi, 331×248 pixel. Using these graphic files, we prepared 167 files for Kana, numbers and symbols.

C. Braille Display Diver

We made a braille display driver program as a braille display daemon for Windows XP, based on the specification information of KGS braille device controller (KBDC) which was provided on http://www.kgs-jpn.co.jp/dev/kbdc.html, with Microsoft VisualStudio 2008 Professional Edition. Our driver is applicable for the following braille displays by KGS corporation: Braille Note BN20A, Braille Note BN40A, Braille Note BN46C, Braille Note BN46D, Braille Note BN46X, Braille Memo BM16, Braille Memo BM24. Braille Memo BM46, Braille Memo Pocket BMPK, and so on. System requirements to use our braille display driver is .NET

Framework 3.5 and Runtime Environment of Visual C++ 2008.

We confirmed the operation of our e-learning program with Braille Memo Pocket BMPK. We also confirmed that the Web browser worked by the order from the JavaScript (Fig 4).

D.Evaluation for the e-learning of Tactile Braille

Our e-learning was evaluated by visual impaired students in the National Kobe Rehabilitation Center for the Visually Disabled. The e-learning was installed on MacBook Pro (Intel Core2Duo 2.5GHz, 4GB DDR2, 17inch, MacOSX 10.5.8) and used as stand-alone, with Windows XP Professional Edition SP3 via VMWare Fusion and Apache 2.2.14 as a web server, which were also installed. The students are asked to use e-learning with or without braille display and compare the learnability. In addition they were also asked to compare the program with or without the voice assistance

We provided open access to this Web-based e-learning for tactile braille. It is accessible from our web site *http://suzume.med.kobe-u.ac.jp/agsb/index.html*).

III. Results

A. Evaluation for the Visually Discrimination of Diagram

As a result of evaluation for 5 diagrams, “+” had significantly higher score than the other diagrams (Fig 5). This result suggest that graphic braille with the raised dot by “+” is highly visible for visually impaired people.

B. e-learning Program for Tactile Braille

Fig 6 shows our e-learning program for tactile braille and the learning flow. First, learners access the Web page of the program via Web browser. Learners choose the type of question here: Level 1, numbers from 1 to 20; Level 2, numbers (1 to 20) and 50 sounds in *Kana* characters; Level 3 numbers (1 to 20), 140 sounds including diphthongs or special sounds in *Kana* and 7 special symbols. After the level is chosen, the program selects one question randomly within the level and display the braille both on the screen and on the braille display (Fig 7).The learner then choose the answer from the four options described in letters and figures by clicking with a mouse or typing the option number. To check the correct answer, the learner clicks the check button or types “q.” The program display if the answer is correct or not. If the answer is wrong, the program display the correct answer. The learner can go back to the level selection by choosing the button “stop” on each page.

C. Evaluation of Our e-learning for Tactile Braille

All the students evaluated that the e-learning with braille display had the higher learnability, regardless of the degree of the impairment. Two students out of 28 with the fourth and five degrees preferred the e-learning without the voice assistance because it took time to wait during the voice assistance, which made the learning speed lower.

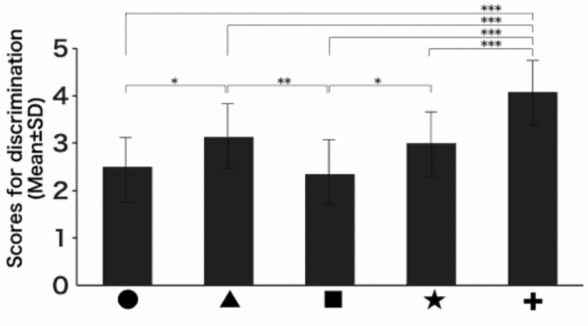

Fig. 5 Result of evaluation for visually discrimination of diagrams
$^{*}P<0.05$, $^{**}P<0.01$, $^{***}P<0.001$

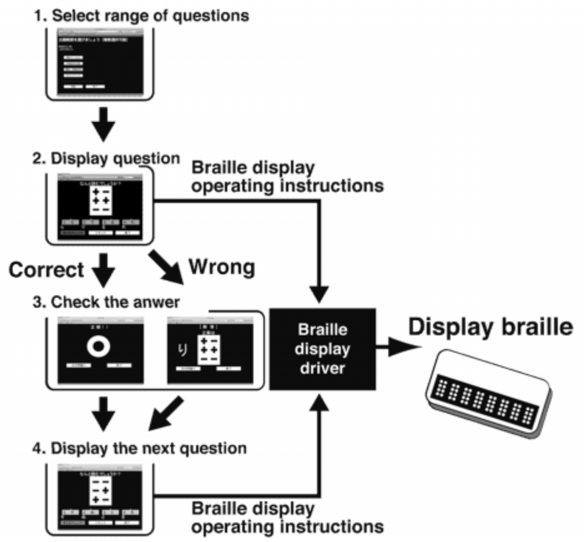

Fig. 6 Our e-learning program and the learning flow

IV. Discussion and Conclusion

We developed e-learning program with voice assistance for tactile braille, by utilizeing residual vision of the visually impaired. Takahashi et al reported e-learning system for the sighted learners [6]. This system is also Web-based, however, their objective is to construct the support system for the sighted, not to raise the braille literacy rate for the visually impaired. Therefore, their Web pages for learning braille is not suitable for the people with vision loss and the system does not cooperate with braille displays.Our e-learning program was favorably accepted by the visually impaired people. We consider our future task as to make more difficult question along with the proficiency of braille learning. The examples of such questions are multiple letters or a sentence. For further improvement, evaluation for our program with more details is underway.We also made an e-learning program on the Web for English braille as a pilot version and provided open access on the(http://suzume.med.kobe-u.ac.jp/edubraille3/agreement.htm l). In addition, we introduced this English braille e-learning to some organization to support the blind and visually impaired people in the USA and the UK, and received the comment that our e-learning can be effective for the sighted learners.

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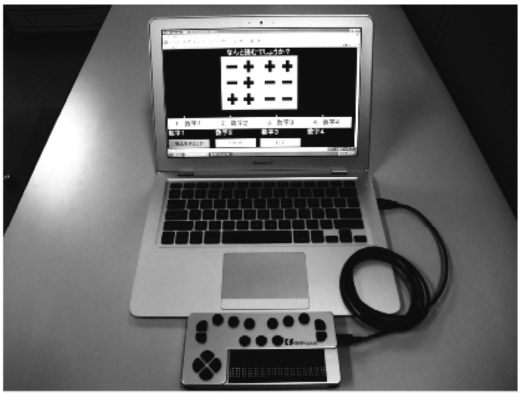

Fig. 7 e-learning with for tactile braille with braille display

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