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Learning Support System using 3DCG and GIF Animation for an Intuitive Understanding of Braille

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Abstract:

Braille is a system of tactile signs for the visually impaired, which represents characters by patterns of six raised dots and is read by touching. While the visually impaired themselves use braille for reading and writing, their supporters should also be acquainted with the system for communication with them. Effectiveness of training of supporters can be enhanced by using three-dimensional patterns, instead of the commonly used two-dimensional ones, to represent braille characters.

The purpose of this study is to develop a learning support system (LSS) using 3D computer graphics (3DCG) and GIF animation for an intuitive understanding of braille. Two functions are added to the existing LSS that enables students to learn with 3DCG not only braille for reading but also braille for writing by visualizing the mirror image relationship between them by the GIF animation. This feature is also helpful for evaluation of students' achievement.

Keywords: 3DCG, GIF animation, Braille, learning support system, intuitive understanding.

1 INTRODUCTION

Braille is a system of tactile signs for the visually impaired to read or write, which represents characters by patterns of six raised dots and is read by touching the patterns from left to right. The French educator Louis Braille, who lost his eyesight at the age of three, developed the system in 1824, which was later named after his name. In Japan, Kuraji Ishikawa, a teacher in a school for the visually impaired, adapted Braille's idea to the syllabic writing system of the Japanese language in 1890. The Japanese word "tenji" meaning braille was coined by combining the words "ten" (dot) and "ji" (character).

"When an e-book is presented in an accessible format on an accessible e-book reader, the user can choose to read the book using text-to-speech, Braille, or magnification," according to Mason (2012). Braille is thus one of the methods for the visually impaired to get information.

Jones and Zambone(2008) tell school library staff : “For example, if a student is blind, his or her IEP (Individualized Education Plan) goals may include reading braille on grade level and the services and accommodations may include access to reading devices, computer software, and braille materials in the media center.” The Japanese governmental guideline for education of public welfare in high schools states that a variety of communication methods including sign language and braille should be covered in teaching on situation-dependent communication methods (MEXT, 2009). These statements imply that supporters of the visually impaired should be able to read/write braille for communication with them. ("Supporters" mean here librarians and teachers of special need schools, as well as students wishing to be ones, who themselves are sighted).

Miura et al. (2009) developed a self-learning program of braille (e-learning system for braille), which proved to be highly helpful for those who acquired visual impairment to learn braille. The representation of braille characters by black and white circles or the plus and minus signs in the system proved to be readily recognized by those who acquired visual impairment. Capabilities of user authentication and management of users’ learning history, lacking in this system, were later implemented by Motoki and Matsuo (2013) in their braille LSS (learning support system) "TENJI TO ISSHO!"

The two-dimensional representation of braille characters used in these systems is satisfactory for reading only or writing (i.e. producing mirror images of characters) only, but confusing for those who learn both reading and writing: a two-dimensional pattern corresponds to a character uniquely if the reading direction is specified (Fig. 1, left), but is ambiguous if either reading direction is possible (MO-TO-KI from right to left, YO-SI-MI from left to right).

The key to solve this problem is a way of representation that permits distinction between a character for reading (in raised dots) and one for writing (in recessed dots). The author, thus, proposes to distinguish raised and recessed dots using three-dimensional computer graphics (3DCG). These 3DCG files were installed in the existing braille LSS "TENJI TO ISSHO!" In addition, 3DCG GIF animation files were prepared for representing the mirror-image relationship between a braille character for reading and one for writing. The purpose of the present work is to improve the braille LSS "TENJI TO ISSHO!" by adding the 3DCG function for better understanding on the learner's part, and to evaluate the effectiveness of this system.

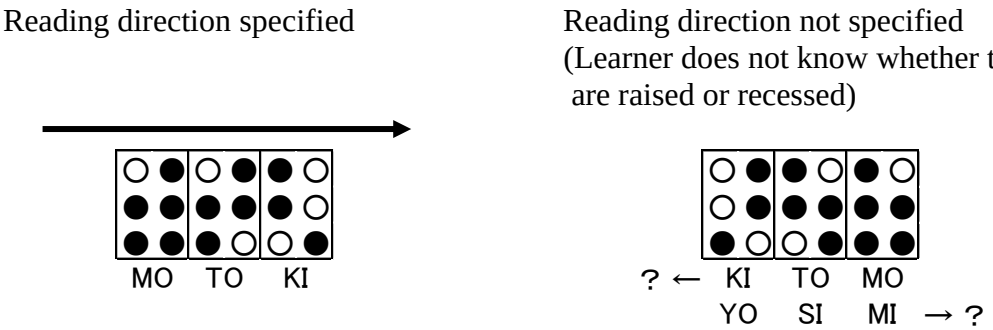

Fig. 1: Unique (left) and ambiguous (right) representation of braille characters

2 SYSTEM

"TENJI TO ISSHO! 3D" is an LSS implemented as a web client/server system. It was developed in the LAMP environment (L = CentOS 5.9, A = Apache 2.2.3, M = MySQL 5.5.12, P = PHP 5.3.6). The system allows anybody to learn to read and write braille anytime and anywhere using a mobile device connected to the Internet.

Two functions were implemented in this system for intuitive understanding of braille:

(1) Display of 3DCG of braille characters, which permits to distinguish raised dots for reading and recessed dots for writing in the Q&A sessions in “TENJI TO ISSHO! 3D”.
(2) Display of 3DCG animation of braille characters, which enables the learner to submit answers to the LSS questions.

Fig. 2 shows the 3DCG images of braille characters corresponding to Fig. 1, as produced by the 3D modelling/rendering package e-frontier Shade 3D© Ver.13.2.3.119. The user can readily distinguish raised dots from recessed ones in this format and, consequently, determine the reading direction.

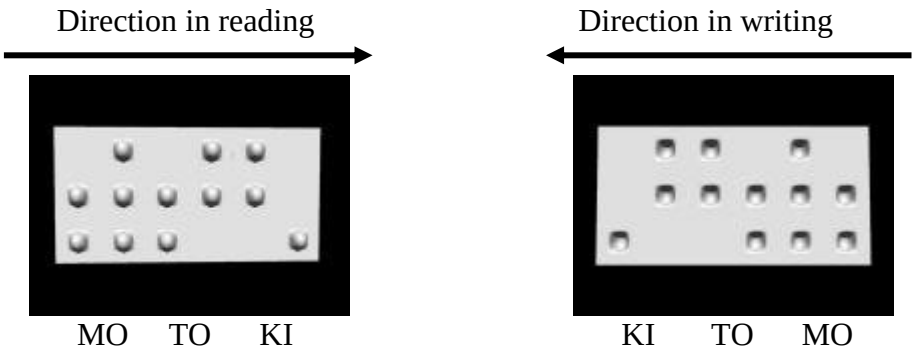

Fig. 2: Examples of 3DCG of braille for reading (left) and for writing (right)

Both 2D and 3D representations are possible in the braille LSS "TENJI TO ISSHO! 3D" (Fig. 3).

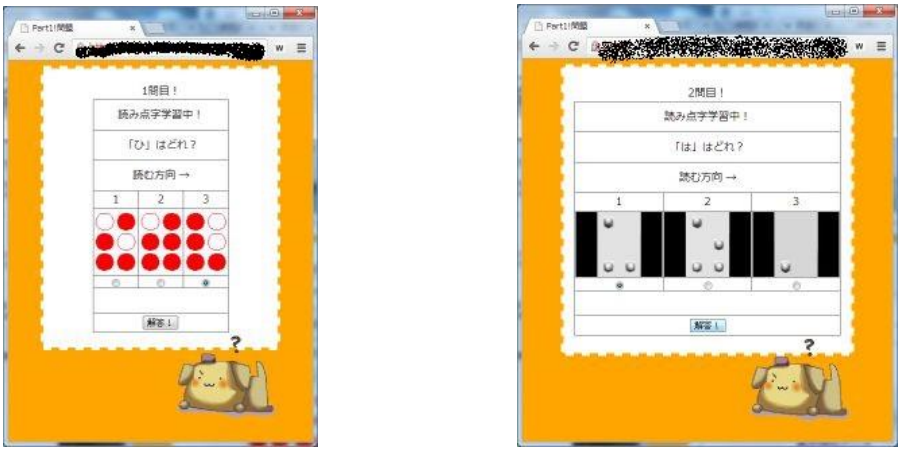

Fig. 3: 2D (left) and 3D (right) image of braille characters in "TENJI TO ISSHO! 3D"

3 DISCUSSION

Students learned braille using "TENJI TO ISSHO! 3D" and were then tested for their achievement. Fig. 4 compares the test scores of individual students with the number of answers submitted by them in the LSS. Analysis revealed a weak positive correlation between the two variables, indicating that the system contributes to improved test scores of the students.

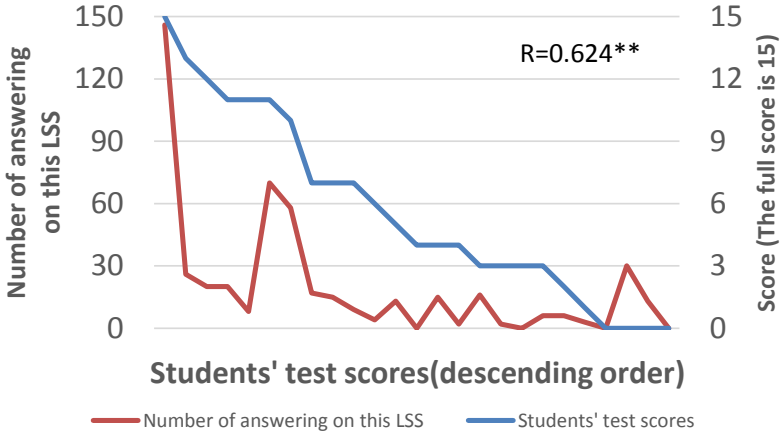

Fig. 4: The comparison of the number of individual student's answers in the LSS and students' test scores. R is the coefficient correlation (t-tested. **: p<.01)

4 ACKNOWLEDGEMENTS

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