Generation of the Certain Kind of Figures Using the Movement Sense of Localized Sound and Its Application

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Abstract. In this report, the easy figure which consists of a line segment and its combination is virtually expressed by the movement sense of the localized sound on a virtual sound screen. In order to create a psychological simple figure, the system which used together the movement sense of localized sound and the input tactile sense guide is proposed.

Keywords: the movement sense of the localized sound, the input tactile sense guide, a figure education.

1 Introduction

We have been examined how a visually impaired person can recognize characters or play a board game using a 2-dimensional virtual sound screen [4–8]. In this report, the easy figure which consists of a line segment and its combination is virtually expressed by the movement sense of the localized sound on a virtual sound screen. In order to create a psychological simple figure, the system which used together the movement sense of sound and the input tactile sense guide is proposed. The purpose of research is applying this system to a student's figure education in a visually impaired school.

2 Generation of Figure by the Movement Sense of Sound

The virtual sound screen is the 2-dimensional space where a vertical axis is expressed by frequency and a horizontal axis is expressed by inter aural level difference 3. Now, we realize the virtual sound screen on a PC, four localized sounds corresponding to four points A (2000Hz, -12dB), B (2000Hz, 12dB), C (400Hz, -12dB), and D (400Hz, 12dB) are specified (Fig. 1). Each of such sound is short sign waves, and output time

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is 300ms. By hearing psychology, through headphone, such sound can be heard from the upper left, the upper right, the lower left, and the lower right, respectively.

By the way, if the sound corresponding to two points on this sound screen is outputted by the suitable time lag (200ms), it is known that the interval of two points could be recognized as a line segment [5]. This psychological property is called the movement sense of the localized sound. If four points are outputted by this time lag one by one, four sides of a square and two diagonal lines will be recognized by the movement sense of sound.

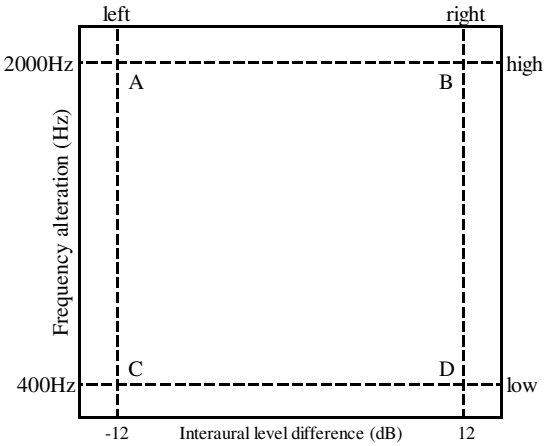

Fig. 1. Four points on a virtual sound screen

Fig. 2. Six slots on the input tactile sense guide

3 Expression of the Figure by the Input Tactile Sense Guide

On the other hand, the input tactile sense guide corresponding to the figure which consists of four slots on square and two slots on the diagonal lines is prepared (Fig. 2). This is made with the transparent plastic board of square, the size is 5cm and the thickness is 3mm. The side lines on the board are 4cm, and are made by the slot of U type with width 1.5mm and depth 0.5mm.

This input tactile sense guide is used placing on a pen tablet. If the nib of a stylus pen is placed on the slot and a side button is pushed, two sounds will be outputted in

200ms of the time lag, the movement sense of the sound corresponding to the line segment would be expressed. While continuing pushing a side button, the output of sound is repeated at intervals of 1000ms.

4 The System for Studying Fundamental Character of Figures

For visually impaired students, in order to study the fundamental character of figures, we create the PC system which consists of the localized sounds and the input tactile sense guide. In this system, the simple figures which consist of four sides and two square diagonal line segments are treated.

Depending on the fundamental character of figures, the following combinatorial figures 1 – 4 are registered into the PC. A teacher (sighted person) can take out a figure suitably using a mouse in accordance with an understanding of a student, and can show a student it. At this time, it is outputted so that the direction of movement sense of sound may become a picture drawn without lifting the brush from the paper as much as possible.

The figures that can be made using n line segments (n = 1, 2, 3, 4, 5, 6) among six line segments. The number of figures are ${}_6C_n = 6! / n!(6 - n)!$.

The figures which will overlap completely if they rotate 90 degrees, 180 degrees and 270 degrees respectively.

The point symmetrical figures (Fig.3 (a), (b)).

The figures not drawn without lifting the brush from the paper (Fig.3 (b)).

In the communication of a teacher and a student in instruction, a student with a headphone can create a figure using the input tactile sense guide, and can show a teacher it.

(a) n = 3 (b) n = 2

Fig. 3. Example of figures

5 Conclusion

We recognize that our system moves almost well. From now on, we will think that our method will be tried to students of a visually impaired school. The fundamental characters of figures that we treat in this report are the number of figures, figure rotation, point symmetry and figures not drawn without lifting the brush from the paper. We would like to examine whether this method can apply also to another fundamental characters, such as the line symmetry and the parallel movement, or it is applicable also to a little more complicated figures.

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