A Study on Sound Image Control Method for Operational Support of Touch Panel Display

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***Abstract*— This paper proposes a sound image control method that estimates the volume setting of loudspeakers to generate a sound image on a desired position. Experimental results confirmed that the proposed method gives the appropriate volume setting.**

I. INTRODUCTION

In recent years, touch panel displays have become popular in use for personal computers. However, it has the serious problem that touch operation is essentially difficult for sight-restricted people.

One way to solve this problem is to instruct a user in the position to be touched by generating a phantom sound image on the position. We are now developing a system with a touch panel display and four loudspeakers as shown in Fig. 1. In this system, sound image control plays an important role. Furuya *et al.* examined the relationship between the volume setting of loudspeakers and the position localized by subjects [1]. To generate a sound image on a desired position, this paper proposes a sound image control method that estimates the volume setting of the four loudspeakers by using the relationship obtained beforehand.

II. PROPOSED METHOD

We examined the relationship between the volume setting of the four loudspeakers and the position localized. The experimental conditions are briefly described in Table 1. The subject sits down in front of the touch panel display on a desk, without being forced to fix his/her head. This is intended to make the system more robust against head movement.

Fig. 2 shows the average of the position localized for each volume setting, together with the 95% confidence interval. As the result, we obtained the 72 pair data of the volume setting and the position localized.

The proposed method estimates the volume setting of the four loudspeakers to generate a sound image on a desired position. To do this, first the nearest eight positions to the desired position are selected from the 72 positions obtained. The volume setting for the desired position is then determined by the weighted sum (or the linear interpolation) of the volume settings for the eight positions selected.

III. EFFECTIVENESS OF THE PROPOSED METHOD

We estimated the volume setting for each of eight positions specified. The same 10 subjects then localized the sound image generated by using the volume setting estimated. The experimental conditions are the same as those in Sec. II.

Table 1 Experimental conditions

Sound	One speech sample of a male
Distance from display to user	About 45 cm
# of volume settings	72 settings that thoroughly cover the area to be touched
# of subjects	10 subjects with a blindfold mask
# of trials	5 times for each volume setting
How to answer	By touching the position localized

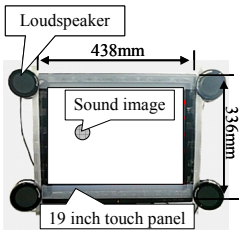

Fig. 1 System overview.

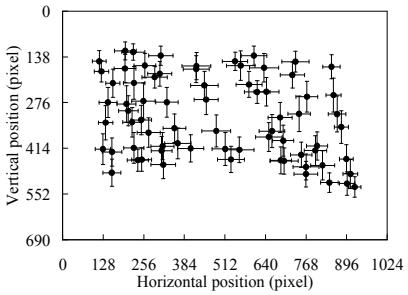

Fig. 2 Localization results.

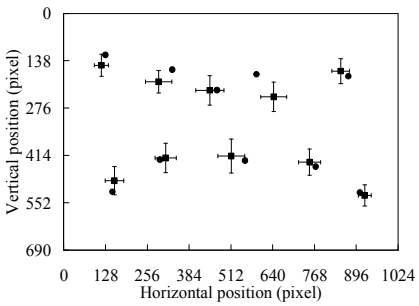

Fig. 3 Position specified (circle) and position localized (box).

Fig. 3 represents the position specified (circle) and the position localized (box). We can see that the proposed method gives the appropriate volume setting.

IV. CONCLUSIONS

In this paper, we proposed the sound image control method and showed its effectiveness. As future work, we plan to introduce a personal adaptation technique to improve the localization accuracy.

REFERENCES

[1] Furuya *et al.*, "Two-dimensional localization of a phantom sound image controlled by the level differences among four loudspeakers in a vertical plane facing a listener," Acoust. Sci. & Tech., Vol. 25, No. 6, pp. 493-495, 2004.