Recreating Tactile Stimulus for Graphic Image: Basic Study

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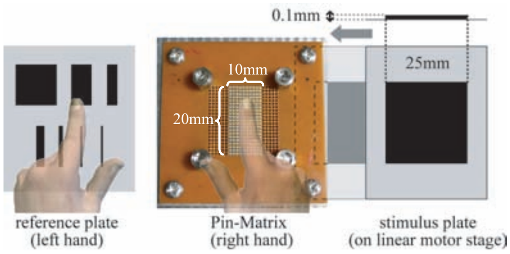
1 Introduction

One of the goals for haptics researchers is to develop a multi-sensory display to convey not only visual information but also tactile information at the same time. There have been enormous studies on how to communicate sense of touch with various devices. These devices are able to convey a variety of tactile information, but it requires a rendering procedure to convert visual stimulus to tactile stimulus. However, only a few rendering methods which associated with visual information have been examined so far. In this study, a method is proposed to recreate tactile stimulus for visual information, especially by using the contour of the image. Because the contour is one of the important information for both vision and touch. As a starting point for a series of study, the stimulus duration of the shape and the perceived size was examined. Stimulus duration is one of the important factors because the perceived shape can be directly affected by that.

In the following experiment, the passive high density Pin Matrix (PM) was used as a tactile display ,to convey tactile signal to the subject[Nakatani et al. 2005]. This passive device is composed of steel pins 0.8 mm in diameter with 1.0 mm center-to-center spacing. The pins' movement is constrained by close-fitting holes in fiberglass boards to prohibit the motion in horizontal direction and to allow free movement in the vertical direction. Each pin samples the height information from the surface pattern and relays it to the finger tip. The surface pattern was scanned by using a linear motor stage, which can move only horizontal direction at specified speed. In the following section, the experimental apparatus and the procedure is described then the result will be discussed.

(a)



(b)

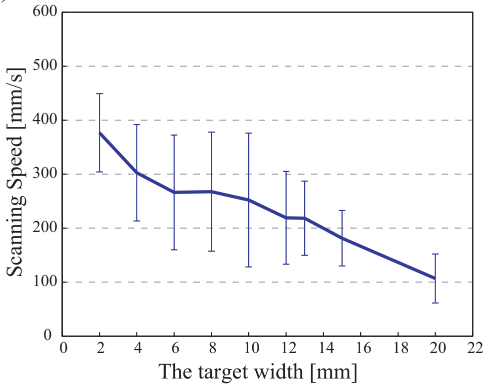


Figure 1: (a): Top view of the experimental setup. The size of the Pin Matrix (PM) was 10×20mm, and the interval between two pins was 1.0mm. (b): The result of the experiment. The narrower the width of the stimulus became, the higher the subjects tended to adjust the scanning speed of the stimulus plate on the linear motor stage.

2 Experiment

Methods Four normal healthy adults (three males, one female) between 22 and 30 years olds attended the experiment . The experimental setup is shown in Figure 1 (a). A square shape (which is 25 mm in width and 0.1 mm in height) stimulus was machine-milled on aluminum plate. This stimulus plate was fixed on a linear motor stage which can move only in horizontal direction. A PM was fixed over the linear motor stage so that stimulus plate enables to touch the bottom of each pin. The size of the PM was 10 x 20 mm, which was enough size to cover whole contact area of the subject's finger pad. A reference plate was also developed by milling machine: this plate had a series of strips with nine different widths (0.5, 1, 2, 4, 6, 8, 10, 15, 20 mm) and they were all 0.1 mm in height. In the trial, subjects placed right index finger on PM, and left index finger on reference stimulus plate. Then subjects were asked to match the subjective width to an assigned width on the reference stimulus plate shown in Figure 1 (a). Subjects could adjust the scanning speed of the linear motor stage by verbally indicating "speed up" or "speed down." Each target width was examined five times in one trial.

Results The data shown Figure 1 (b) indicated that the decrease in target width resulted in an increase in the scanning speed of the stimulus plate. This result suggests that the perceived width of the stimulus can be affected by the stimulus duration. In addition, the magnitude of the variance increased as the target width decreased, especially when the target width was smaller than 10 mm. One of the reasons can be that the scanning speed was faster than 200 mm/s. The range of the speed at which people usually experience in daily life is reported as 50 - 200 mm/s. Therefore, outside this speed range may result in misperceiving the size of the moving objects, if people guess the size empirically.

In future work, a variety of machine-milled shapes can be use as stimuli to investigate the possibility to represent different size of the shapes and textures with the same pattern. Moreover, a shape that contains multiple contours will be examined to convey more complicated shape information with various stimulus durations.

References

NAKATANI, M., KAJIMOTO, H., KAWAKAMI, N., AND TACHI, S. 2005. Tactile sensation with high-density pin-matrix. In *Proceedings of ACM Symposium on Applied Perception in Graphics and Visualization*, 169.

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