High Resolution Tactile Display

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1. Introduction

We proposed a tactile display which can present the sense of presence and movement of an object. To develop the display, we chose to use a pin-matrix type tactile display whose tactors move only in the vertical direction. The vertical indentation was decided to be suitable for this application, because it can achieve high spatial resolution of the contactors. However, in order to display the sense of presence and movement of an object effectively, we need to find out and utilize the suitable resolution. Therefore we conducted an experiment to evaluate the suitable resolution for shape recognition with a pin matrix[1].The result suggested that the interspacing of pin-rods should be less than 1.5 mm for shape recognition: , and 1.0 mm can provide rich enough information for recognizing the shape underneath a pin matrix in active touch. Moreover, in our follow-up test, suggested that the performance is not so improved even if the resolution of the pin matrix was made finer than 1.0 mm in our additional test.

Based on this result described above, we determined that the vertical indentation would be the effective stimulating method to convey tactile signal with high resolution. In addition, we set the horizontal resolution to be 1.0 mm, according to the shape recognition performance of the humans.

2. Developed System

We decided to use a passive high-density pin matrix as a tactor for representing the presence of an object through the tactile sensory channel. This passive device is composed of 441 (21 x 21) steel pins 0.8 mm in diameter with arbitrary center-to-center spacing larger than 1.0 mm. The pins' movement is constrained by the close-tolerance holes in fiberglass boards in order to allow free movement in the vertical direction and essentially to prohibit free motion in the vertical direction. Each pin of the passive Pin Matrix was driven by using the velocity controllable motor stage that can move only in 2D direction.

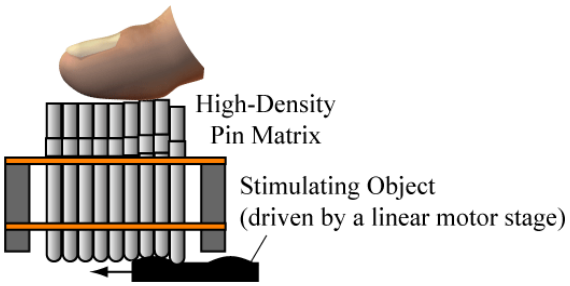

Figure 1 Proposed method to actuate a passive High-Density Pin Matrix

Tactile reconstruction with high resolution was adopted because of the following reasons: the shape information, especially the contour of an object, can be presented more clearly and the sense of the presented objects movement (i.e., velocity) is evoked more strikingly with our proposed method. Also a passive pin matrix is suitable to create moving stimulus because of its mechanical characteristics. In other words, the pin matrix exhibits the "filtering effect" originates its mechanical property, which is already analyzed in a part of related studies[2].

When developing high-density tactile display, there are four advantages of adapting a passive pin matrix as follows: 1. Ease to change the resolution, 2. Simple actuation mechanism, 3. Durability and 4. Scalability. The method we propose is really easy to increase or decrease the number of pin-rods according to the application. Therefore, it is also possible to develop a palm size tactile display by just adding the pin-rods with our proposed method.

References

[1] M. Nakatani, H. Kajimoto, N. Kawakami and S. Tachi, “Tactile sensation with high-density pin-matrix”, In Proc. of APGV ‘05, p. 169, 2005.

[2] R. Kikuuwe, A. Sano, H. Mochiyama, N. Takasue and Hideo Fujimoto, "Enhancing Haptic Detection of Surface Undulation", Trans. on Applied Perception, Vol. 2, No. 2, pp. 46-67, 2005.