

Presentation of Tracing Sensation to Fingertip Using a Rotating Disk

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I. INTRODUCTION

The elucidation of tactile perception, particularly the discrimination of texture and frictional forces of objects, depends on the effective presentation of tracing sensations to the fingertip. While several methods have been proposed to emulate realistic tracing motions through the use of rotation mechanisms [1][2], these devices often manifest as large or complicated. On the other hand, previous research has highlighted the low-ability of human in accurately perceiving the orientation of the lateral component of fingertip skin deformation [1][3], thus suggesting that exact replication of horizontal skin motion may not be strictly required. With this in mind, this study presents a novel approach in which a disk of similar dimensions to the fingertip is rotated while the fingertip remains in contact with the center of the disk to present a tracing sensation.

II. PROTOTYPE

A device was developed that is worn on the finger and makes contact between the rotating disk and the fingertip (Figure 1). Using motion capture, the system controls the rotation of the disk in sync with the tracing motion. The device has considerable potential for future miniaturization.

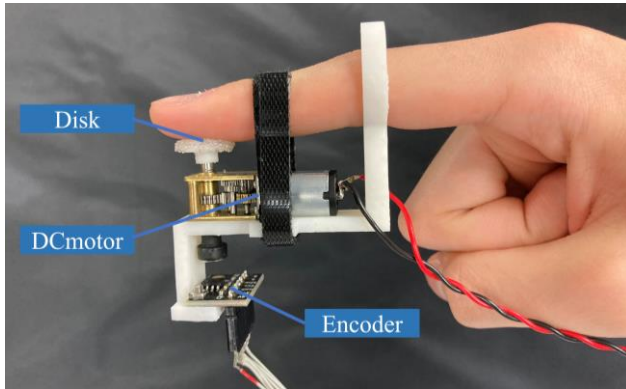


Figure 1. Prototype appearance and configuration

III. EXPERIMENT

To verify the effectiveness of the method, we conducted an experiment to assess the realism of the sensations presented by the device, comparing with a real plate. This study

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incorporated an examination of the effect of surface texture, consisting of two different sub-experiments with different surface materials. In Experiment A, the device disk and comparison plate were polished uniformly with #600 sandpaper to produce a refined surface. In Experiment B, a uniform application of F30 glass beads was used to create a roughened surface. 10 participants were recruited (10 males, 22 to 28 years old) for Experiment A, while 10 participants were recruited (9 males, 1 female, 22 to 28 years old) for Experiment B. 6 participants were common to both experiments.

Five experimental conditions were used: no rotation (Off), constant clockwise rotation (CW), constant counterclockwise rotation (CCW), clockwise rotation during right tracing + counterclockwise rotation during left tracing (RCW), and clockwise rotation during left tracing + counterclockwise rotation during right tracing (RCCW).

The results of the experiment are shown in Figure 2. According to the Friedman test results, significant differences were observed between the off condition and almost all other conditions. This suggests that the presented stimuli significantly increased the realism of the tracking experience. Conversely, minimal differences were found for rotation patterns or textures. Nevertheless, in Experiment B, the realism of RCW and RCCW seemed relatively high, suggesting that the alternating motion of the direction of rotation might be effective in the rough texture scenario.

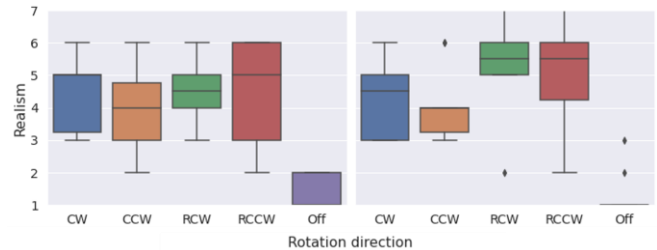


Figure 2. Result of Experiment A (left) and Experiment B (right)

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