

# Preliminary study on the asymmetry of skin deformation between radial and ulnar side of finger pad\*

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**Abstract**— The stick-slip phenomenon is an important part of roughness perception in finger-surface interaction. We observed that when exploring a rough surface with finger pad, the stick-slip phenomenon is more likely to occur in ulnar direction than radial direction. In this study, a 3D measurement was performed, and showed the different skin deformation between each sides of finger pad, which may explain the direction-dependent stick-slip phenomenon.

## I. INTRODUCTION

The stick-slip phenomenon, which occurs when a finger explores a rough surface, plays an important role as part of haptic perception. Artificial simulation of this phenomenon will be useful for the development of haptic presentation devices, and clarification of the cause of this phenomenon will be relevant to the discussion of the improvement of grasping force. The occurrence of stick-slip phenomenon is strongly related to the properties of finger pad. It was shown that the locally hard area on finger pad is more slippery than soft one, and the amount of strain energy in fingerprints differs depending on the exploring direction of the flat plate [1][2].

We have observed that stick-slip phenomenon is more likely to occur in the radial direction than in the ulnar direction when the finger traces a rough surface in the right and left directions (radial and ulnar directions) with a constant pressing force. We hypothesized that the direction-dependent stick-slip phenomenon was due to asymmetric skin deformation on both sides of the finger pad when the finger was exploring in the radial-ulnar direction. In this study, we measured the deformation of the skin on the ventral side of the finger pad using a 3D microscope (VR-3100, Keyence) under 1N-load applied with a caliper, and compared that to no-load condition. The principle of the measurement is to project the light of the stripe pattern onto the finger pad and see the deformation of the stripe pattern. The shape of the finger pad is obtained from the distortion of the stripe pattern using triangulation ranging (Figure 1. ).

## II. MEASUREMENT RESULT OF TWO SIDES OF FINGER PAD

The cross-sectional curve of the ventral side of the finger pad are shown in Figure 2. The blue and brown curves indicate the concave and convex curves of radial side (thumb side) and ulnar side (little finger side) respectively. The light curves indicate the condition under no-load and the dark curves indicate the condition under 1N-load. It can be seen that the ulnar side swelled up and the unevenness became significant

under the 1N-load condition. The wrinkles caused by the fingerprints became deeper, and the skin behaved as folding along the fingerprint. The ulnar side also swelled up but the unevenness almost unchanged and even appeared smoother. This asymmetry of deformations suggests that the skin around the radial side is considered to be more elastic and softer than that around the ulnar side, which may lead to the direction-dependent stick-slip phenomenon.

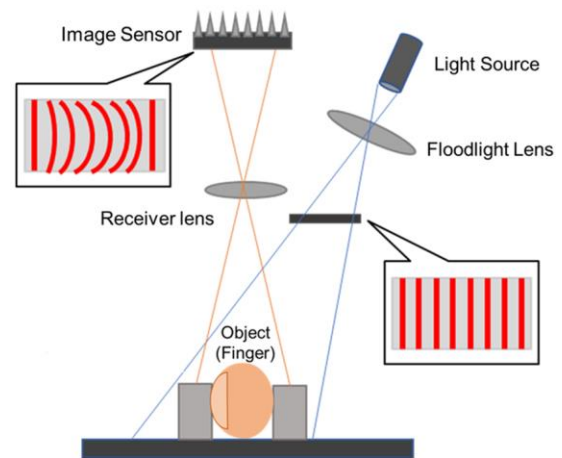


Figure 1. The schematic diagram of the measurement system.

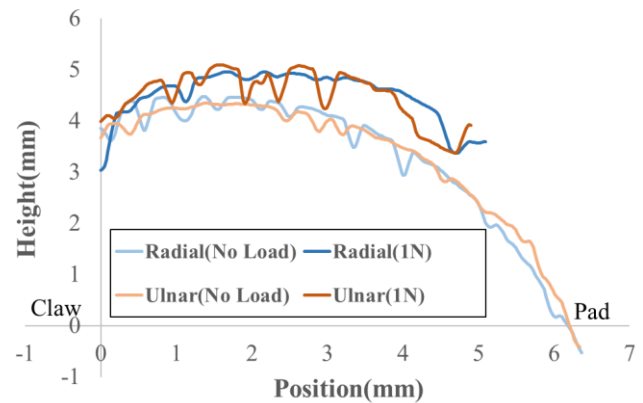


Figure 2. Measured cross-sectional curve of the ventral side of the finger pad.

## REFERENCES

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