Finger Force and Position Measurement without Obstructing Touch Interaction

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Abstract—In order to analyze tactile sense of touch in manipulating real-world objects, haptic information is required to be captured without obstructing touch interaction. This study designed a system that enables to simultaneously measure finger force and three-dimensional position without preventing tactile sense of touch. The system consists of a contact force sensor which estimates contact force through deformation of finger, and a magnetic sensor to obtain three-dimensional position of the finger.

I. INTRODUCTION

Endoscopic surgery enables minimally invasive treatment as well as offers surgeons high technical skills. In order to analyze surgical skills, some studies developed force measurement devices by attaching force sensors to specific surgical forceps [1]. As surgeons manipulate organs and strings based on their sense of touch, this study aims to analyze tactile information that is sensed through their fingers. From this point of view, simultaneous measurement of position and contact force on tip of a finger is needed. However, conventional force measurement systems attached to the top of the finger could obstacle sense of touch.

This paper presents a basic design of a system that enables to measure finger force and position without preventing touch interaction. The implementation of the system and preliminary test results are introduced in this paper.

II. METHODS

In order to capture finger force without obstructing touch interaction, we employed the Haplog (Tech Gihan Co. Ltd) [2] as a force sensor. This sensor detects deformation of a tip of a finger and estimates the finger force based on initial calibration reflecting the individual shape of fingers. Also, we attached a 6DOF magnetic tracking device (3D Guidance MedSAFE sensor manufactured by Ascension Technology Corporation) to the back side of the force sensor, as shown in Figure 1 (a). We synchronized force profile and positional data in real time. This allows us to measure contact force and finger position simultaneously in touching real-world objects.

III. RESULTS

We will analyze tactile sense of touch in extending real-world objects. Therefore, migration length is important in this study. We tested this system whether it detects the migration length correctly. The top of the finger is touched to the desk in order to stabilize it. We extend 100mm rubber to 300 mm along to a ruler. We get the data “199.2mm”. This error 0.8mm is small enough, and it will not affect for analyzing tactile sense of touch in manipulating real-world objects .

Next, we synchronized force profile and positional data in real time. In order to test whether we synchronized them correctly, we conduct a test. The result is shown in Figure 2. We pushed the desk in every 2 seconds. x-axis means time [sec], y-axis of the left means z coordinate (solid line) ,and y-axis of the right means contact force [N](dotted line) . Figure 2. shows that we synchronized force profile and positional data in real time because contact force is occurred at the time the finger attaches on the desk and z coordinate become minimum.

IV. CONCLUSION

We developed the system that enables to measure finger force and position simultaneously without preventing tactile sense of touch. The preliminary tests confirmed the accuracy of position measurement and synchronization to force profiles. As future works, we will use this system to investigate haptic interaction in manipulating rubber materials.

REFERENCES


Fig 1. (a) Tactile force and position sensor, (b) application to index finger

Fig 2. Position and force profiles in pushing operation

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