Construction of super-micro sense of force feedback and visual for an elastic body

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Abstract

This research aims to develop a combined sense system that uses the sense of force feedback and the visual by the shape of microscopic features of a micro sample. The visual and the sense of force feedback were expanded in an effort to improve the efficiency of the skill to operate the micro sample by creating conditions similar to actually feeling samples that are large enough to actually grip by finger. In this basic research, we use a haptic device that presents the expanded reaction force generated from virtual object of a micro sample.

Based on a feedback force presentation experiment using a reaction force, a feedback force transmission simulation model of actual force transmission was constructed. In this experiment, two control approaches were used such as position control and hybrid control. We discussed our experimental results considering the system's advantages and problems.

Key words: *Force feedback, Haptic interface, Simulation*

1. Introduction

Currently, bioindustry, the medical field, and the field of semiconductor production expect to see advancements in the efficiency of micro-technology. Recently, a current study focused on post-genomics, the field that investigates the use of the enormous amount of information analyzed. The field of semiconductor research also has incorporated nanoscale productive processes since 2004. It is difficult to manipulate micro-technology directly, however, because of its dependence on sight and the need for a considerable mastery of skills.

As a method for solving this problem, the reaction force of a minute sample improves the efficiency of functions such as identification and operation by utilizing the feedback force to the worker.

This study describes the development of a compound system that utilizes sight with a microscope and a force feedback manipulator.

This fundamental research utilizes a haptic device to show the amplified feedback force from a virtual minute sample. We also describe an interface that displays a graphic in a microscope and commands the x-y stage on the microscope.

2. System Structure

2.1 Summary of Structure

The structure of the system is shown in Figure 1. This system consists of a metallographic microscope, an automatic x-y stage on the microscope, a feedback stage controller to control the x-y stage, a hapic device for transmitting force feedback (Fig. 2), a minute power sensor (Fig. 3), and the PC with which I control and operate them.

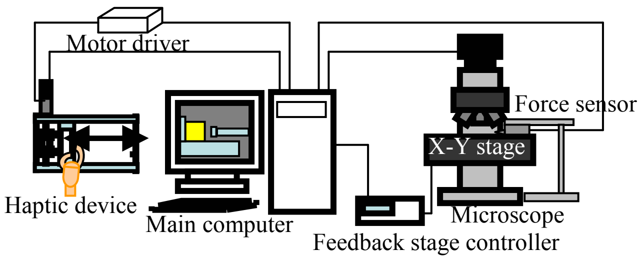

Fig. 1. Schematic diagram of system structure

Fig. 2. Haptic device

Fig. 3. Micro force sensor

2.2 Microscope Image Interface

In this paper, we constructed the microscope image interface shown in Figure 2. The functions of this interface are:

- to display the graphic shown from a microscope through a digital camera
- to move the x-y stage by pushing a button on the interface
- to measure the reaction force between a sample and sensor by a micro force sensor
- to display the virtual object through simulation and check any deformation of it.

Therefore, we are able to check for deformation in each minute sample using microscope images and the computer simulation.

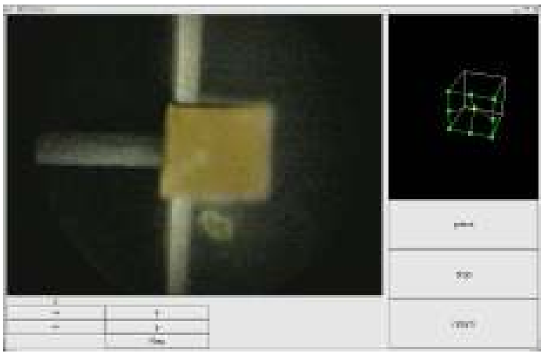

Fig. 4. Image of interface

3. Construction of virtual elastic body

Fig. 5 shows the construction of the virtual elastic body used in this study. It includes nine mass points and the spring-damper elements. The horizontal element and vertical element are constructed from a parallel model made with a spring and damper. The virtual elastic body contains fixed mass points, except the center mass point which acts as a condition of constraint.

We give the sample displacement and measure the reaction force to identify the elastic coefficient and viscous modulus on the simulation. We measure the elastic coefficient on the basis of the relation between the reaction force and the displacement, and the viscous modulus on the basis of the relation between time and displacement.

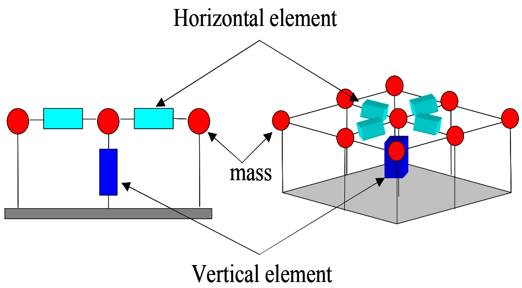

Fig. 5. Schematic diagram of dynamic model

4. Feedback Force Presentation Experiment

In this Chapter, we used the haptic device described in Chapter 2. We attempted to evaluate whether a worker can grasp an amplified micro reaction force form virtual object with the haptic device.

The experimental method of force feedback transmission involves hybrid control with a master-slave method. A worker touches the virtual object described in the previous chapter in PC. Then, the generated torque is amplified and transmitted by the haptic device.

These experimental results are shown in Fig. 6, Fig. 7, and Fig. 8. Fig. 6 and Fig. 7 use the same time line. In Fig. 6, the horizontal axis represents time in (seconds) and the vertical axis represents the angle (in degrees) of the master and slave. In Fig. 7, the horizontal axis represents time and the vertical axis represents the torque (milli newton meters) supplied by the reaction force in the slave and the torque transmitted to the master. In Fig.8, the horizontal axis is time (in seconds), the vertical axis is the torque (milli newton meters) supplied by the reaction force in the slave and the torque amplified ten times in the master.

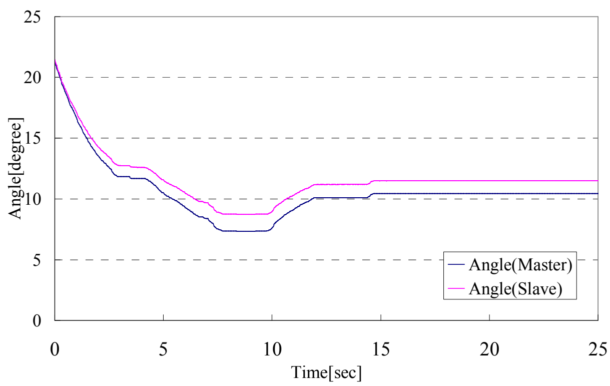

Fig. 6. Experimental result of hybrid control (Angle)

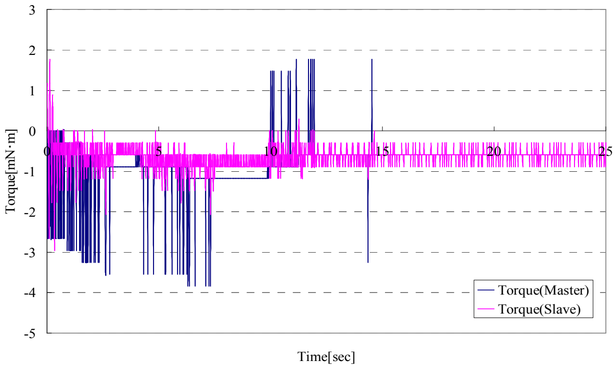

Fig. 7. Experimental result of hybrid control(Torque)

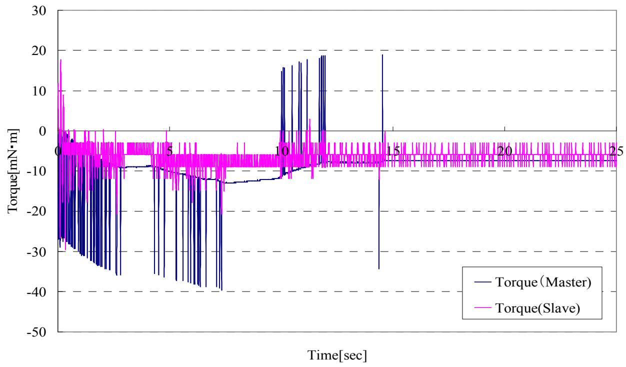

Fig. 8. Experimental result of hybrid control
(Torque is amplified 10 times.)

We can confirm that the torque of the master was extended to 10[mN / m] according to Fig. 8. In addition, we can feel the elasticity to a slight degree by touching a virtual object with a haptic device that we actually built. However, we can not feel the softness when we touch a sample with haptic device. Considering the causes that can not feel the softness, it is likely that the mechanism of the haptic device is not pertinent, and the reaction force of a visual object is too small to induce with a haptic device.

5. Conclusion

In this paper, we evaluated whether force feedback is amplified by touching a virtual object with a haptic device in a PC. We can amplify the reaction force but we can not present a large enough reaction force for a worker to feel its elasticity.
In the future, I plan to build a system to show a minute reaction force extended precisely. Future research will focus on a system that will detect and express reaction forces more precisely. The system will be tested using a smaller sample. Therefore, I will build a manipulator and develop a system around it.

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