Construction of a super-micro sense of force feedback and visual for a micro object

K. Miyamoto, E. Hayashi and T. Sonoda

Graduate School of Computer Science
And System Engineering
Kyushu Institute of Technology
680-4, Iizuka City, Fukuoka, Japan, 820-8502
(Tel : 0948-29-7780; Fax : 0948-29-7780)
(miyamoto@mmcs.mse.kyutech.ac.jp)

Abstract: This research aims to develop a combined sense system that uses the sense of force feedback and a visual image based on the shape of microscopic features of a micro sample. It is thought that the efficiency of minute work would be improved if the operator could obtain a sense of force while using the manipulator. We used a cantilever to touch the minute object, and obtained anti-power from the degree of its bend. We constructed a haptic device that provides force feedback to the operator. The operator can feel the force through this device when he touches the sample with the cantilever. In addition, when he uses the hapic device and the simulation the operator will feel as if he is touching the sample.
Keywords: Haptic device, Simulation, Force feedback, Micro- manipulation

I. INTRODUCTION

Technologies that allow the accurate performance of minute work are now being sought for both medical treatment and in the field of semiconductor manufacturing. Such minute work is improved by using micro manipulators, but their operation is difficult because the operator cannot use his sense of force; he relies only on sight through the microscope. As a result, a person skilled in the use of the technology is needed for minute work. It is thought that the efficiency of minute work would be improved if the operator could obtain a sense of force while using the manipulator

This study describes the development of a system that uses not only the sense of sight from the microscope but also a sense of force from the manipulator. For this fundamental research, a system was built to obtain anti-power when a minute sample is being touched. A cantilever was used to touch the sample, and the anti-power was obtained from the degree of its bend.

We constructed a haptic device that provides force feedback to the operator. The operator can feel this force when he touches the sample with the cantilever. In addition, when he uses the hapic device and the simulation the operator will feel as if he is touching the sample.

II. System Structure

II- i . System Structure

The structure of the system is shown in Fig. 1. This system consists of a microscope, an automatic x-y stage on the microscope, a piezo stage, a feedback stage controller to control the x-y stage, a piezo stage controller, a haptic device for transmitting force feedback (Fig. 2), a cantilever (Fig. 3), and the PC with which they can be controlled and operated.

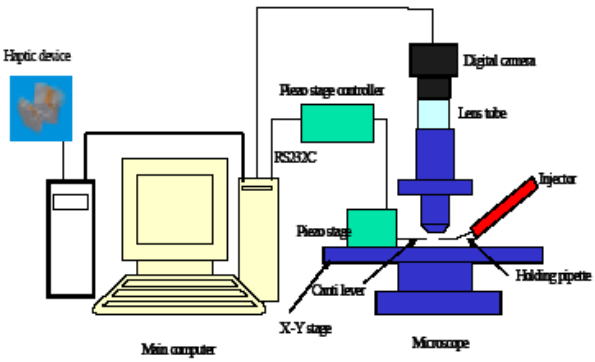

Fig. 1. System structure

Fig. 2. Haptic device

Fig. 3. Cantilever

II- ii . Haptic device

Figure 4. is a summary figure of the haptic device that we built in this study. This device consists primarily of a rotor, a laser, and a PSD (Position-Sensitive Device) mainly. We picked up a coil installed to a rotor with a different polarity magnet, and generate d electro- magnetic induction by an electric current and magnetic force. We can detect the angle of rotation to the laser and PSD. We convert this current output into a voltage signal and use it to position the rotor.

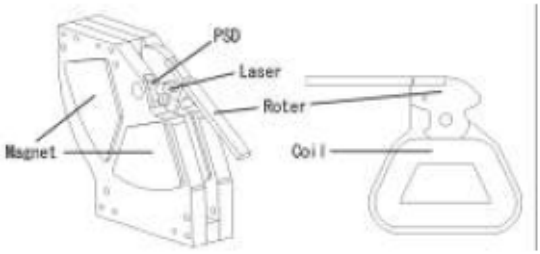

Fig. 4 Summary of the haptic device

III. Measure the anti-power

We used the anti-power to determine the power that should be applied over the minute object. In this experiment, we touched the minute object with the cantilever (Fig.5) and obtained the anti-power from the degree of its bend. As such, we were able to determine the power that should be applied to the minute object.

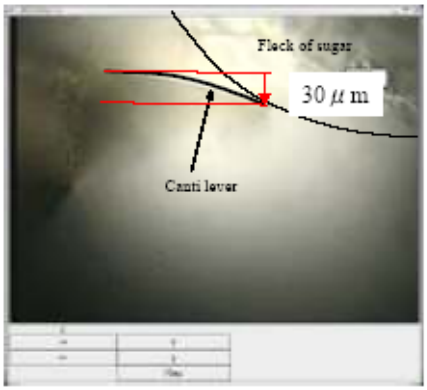

Fig. 5 Bend of cantilever

We found the anti-power by applying Hokke's law to the degree of the cantilever's bend, which gave a result of 3.3 μ N.

IV. Deform simulation of the sample

In this study, we made the deform simulation of a minute object. Figure 6 provides a summary of the GUI. We used OpenGl, which is a graphic tool to draw the object and that allows us to choose the shape of the sample a cube or globe. The dynamics model of the sample consisted of a spring-mass array element in a vertical and parallel direction for each mass point. In the calculation method for the displacement, it was assumed that the force is given only on a central mass point. The Runge-Kutta was used, and calculations were made every 0.1 msec. To use this calculation result, the displacement of the neighboring mass point is calculated. In addition, a sample can be observed from various viewpoints, and the deformation of a sample that cannot be seen with the microscope can be checked.

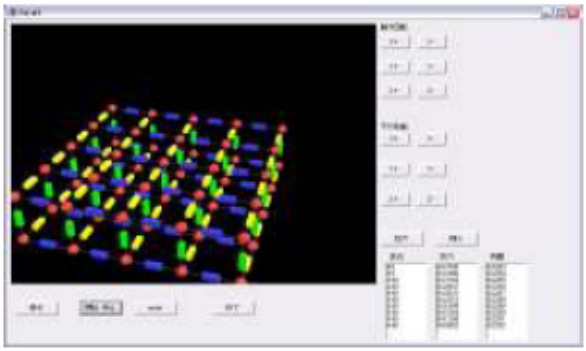

Fig. 6 GUI of simulation

V. Conclusion

In this paper, I have described anti-power measurements that are carried out when an operator touches a minute object, anti-power exposition (Haptic device), and deform simulation of the sample.

With the cantilever , we can touch the sample (Fleck of sugar) with a cantilever and measure the anti-power from the degree of its bend.

We constructed a haptic device, and carried out a deform simulation of the sample. It was previously not possible to watch both a cantilever and a minute object, but we now can observe deformation of the object through a simulation. In addition the operator can feel the anti-power from the haptic device.

We last address the tasks that lie ahead. First, it is clear that the value obtained for the anti-power has a

margin of error. In addition, we used a fleck of sugar as the minute object in the present study, but it is larger than the minute objects for which this technology will be applied. It will therefore be necessary to try a smaller object.