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Making difficult things easier and simpler with a manipulation system

Manipulators are used to perform fine operations under a microscopic field of view, and generally require a skilled technique. To create an easy-to-use manipulation system, we applied mechatronics and attached it to a microscope. Except for the replacement of the microscope's objective lens, this newly developed system is capable of all electric operation.

Micromanipulators are used in various biotechnology research and development applications and in the manufacturing of fine electronic components. To perform fine operations under a microscope's field of view with a micromanipulator, an operator needs to develop a skilled technique. This technique is often very difficult to master.

Therefore, we developed a manipulation system that can be more easily operated under a microscopic field of view. Using this newly developed manipulation system, we collaborated with the Central Research Institute for Experimental Animals (Kawasaki, Japan) and succeeded in practical application.

In this Application Note, we describe our manipulation system and its performance.

Manipulation system

The manipulation system consists of an electric three-axis manipulator, an electric two-axis *xy* stage, a focus actuator, a piezoelectric actuator, and a pump, and is mounted on a microscope. These devices are controlled by a personal computer (PC) via the electric panel. There is also a camera attached to the microscope, so that the operator does not need to look into the microscope's eyepieces. The manipulation system is operated with a joystick (**Fig. 1**).

Because the manipulation system is an electric drive system and the operator views the image from the camera attached to the microscope, the work location is not restricted to the microscope area—the system can be operated from a location other than the microscope

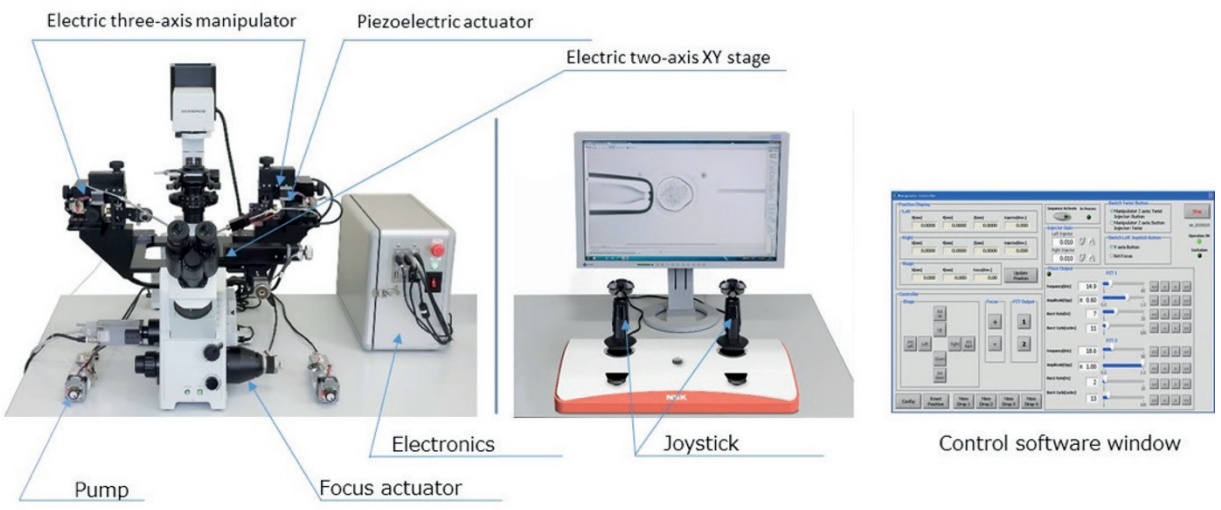

Figure 1 | The manipulation system..

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installation location. As a result, it is possible to reduce the influence of vibrations caused by the operator under the microscope field of view. Additionally, even when the microscope is installed in a safety cabinet, the operator can operate it with a comfortable working posture (**Fig. 2**).

Figure 2 | State of work.

Piezoelectric actuator

Piezoelectric actuators are used to perforate egg cells via nanopositioner technology[1]. A glass needle is filled with Fluorinert, and the piezoelectric element is used to vibrate it at a frequency on the order of kilohertz. With this piezoelectric actuator, a perforation operation can be performed with minimal damage to the egg cell (**Fig. 3**).

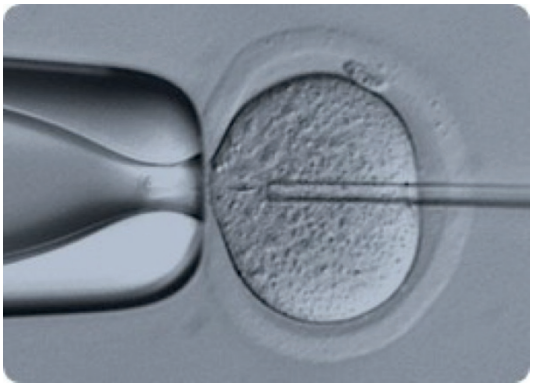

Figure 3 | Perforation motion.

Automatic function

In the manipulation system, all driving elements are electrically driven and controlled by a PC. By utilizing the electric drive, one can control the sequence in which each axis drives in conjunction. By executing a particular sequence, for example, it is possible to automatically go back and forth between stored positions. As a result, it is not necessary for the operator to adjust the position under the microscope field of view, and it is possible to realize easy operation (**Fig. 4**).

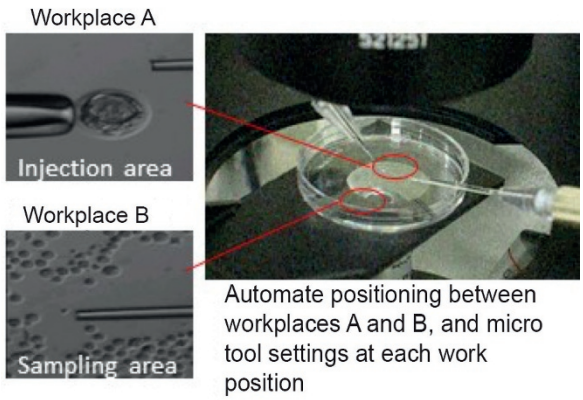

Figure 4 | Automatic function.

Performance evaluation results

We used our manipulation system[2] for DNA injection and embryonic stem cell injection, and our results confirmed that the new system yields the same outcomes as observed with the conventional technology. We also confirmed that intracytoplasmic sperm injection (ICSI) is possible with mouse egg cells[2]. Additionally, we confirmed that the developed automatic function was able to improve work efficiency[2].

Conclusion

The manipulation system is used for cell operation in the biotechnology field, as well as for manufacturing electronic components in the industrial machinery field.

We will continue to improve the performance of the manipulation system in order to contribute to the advancement of biotechnology research.

1. Tanaka, N. *NSK Technical Journal* **680**, 29–35 (2006).
2. Tanaka, N. *NSK Technical Journal* **688**, 35–44 (2016).