MeDaCA: Method of Direct Manipulation and Conditions for Acoustic Tweezers Grasping Medaka

Takahito Murakami

This paper was to generate a sound field, consider conditions for grasping and moving live fish underwater using an acoustic lens-based method, and demonstrate this through experiments. To this end, we first experimented using underwater ultrasonic transducers and acoustic lenses to grasp objects larger than conventional methods. Then, based on previous studies, an acoustic trap was created, and a method for grasping objects was considered. We chose to use acoustic vortex (AV) because it does not require high-speed switching.

AV is a method using orbital angular momentum (OAM) to generate vortices by sound. Acoustic vortices have also been demonstrated for stable 3D trapping of Lacey particles. Acoustic traps can usually exist at the point of convergence (focal point) of sound waves, and they stably levitate particles.

Acoustic lenses are created using 3D printers. Acoustic lenses require high-definition modeling, and sound waves are not transmitted if there are bubbles or other defects in the lens.

We reproduced the phase difference in Matlab using the method of Marzo et al. 2016. In addition, acoustic lenses must consider the density difference between the acoustic lens material and the fluid that creates the trap.

Two transducers were used in the experiment in a tank filled with water; called PA and HIFU. The HIFU has a higher power output than the PA, but the PA has a more adjustable focus range. The transducer was placed horizontally and vertically in relation to the surface of the water.

In horizontal, 80 Vpp was input to HIFU and 50 Vpp to PA, and in vertical, 50 Vpp to HIFU and 25 Vpp to PA. After two experiments, one artificial and one biological, both HIFU and PA were able to grasp very light Styrofoam raw particles in the vertical. However, when the experiment was conducted with Medaka fish, HIFU alone succeeded in grasping Medaka fish fry up to 8 mm in size, which was larger than AV48.

This study describes the conditions under which live fish are trapped and trapped in water. The widening of graspable objects is an important factor in achieving practical acoustic tweezers.

We believe that this study contributes to expanding the possibilities of ultrasonic manipulators by showing that it is possible to grasp a moving living object and by demonstrating the conditions under which such grasping is possible. The expansion of human grasping capability will not only enable us to observe things that could not be observed before and lead to the creation of new research fields and treatment methods, but also accelerate the possibility of achieving diversity through better education and a society without physical limitations. In addition, a grasping mechanism without environmental restrictions will be important in the coming space life.

（Thesis Supervisor: Yoichi Ochiai）