INJECTION TASK DONE BY DAPHNIA MAGNA AS A BIOMICROMACHINE

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Introduction

We have been investigating to apply the micro-organism's taxis to control their behaviors to make bio-micromachine using microorganisms such as Paramecium (galvanotaxis) [A. Itoh, 2000], Euglena (phototaxis) [A. Itoh, 2007], etc. However, to control protists precisely and to attach tools for protists are very difficult.
Therefore, we are now investigating the applicability of *Daphnia magna*. Daphnia has positive phototaxis to the blue light, so we can control its behavior by the direction of the blue light. The controllability of Daphnia is much better than Paramecium [A. Itoh, 2010]. Daphnia has also an outer shell that we can easily glue operation tool on.

In this study, we tried to attach some special tools to do the special job by Daphnia.

Methods

The effect of the blue light to Daphnia's phototaxis is strongest, and that of the red light is weak. Therefore, we designed the control method by using blue light to control the Daphnia's motion and by using red light to illuminate the experimental field. We used petri-dish like shallow pool with 48 blue LED installed in the side wall. We can control Daphnia manually using a joystick or automatically by image processing method.

To attach a special tool to Daphnia, we prepared a v-grooved acrylic plate. A Daphnia was put on the groove. Then the Daphnia's back was wiped out and operation tool was attached on the back by cyanoacrylate (CA) adhesives.

Results

We first tried to puncture a balloon by a needle installed on the Daphnia's back. We attach wing type operation tool to Daphnia first, then attach the needle on the wing. The needle is 0.2mm diameter stainless needle The wing could stabilize the Daphnia's posture so much that Daphnia could swim well after installing the heavy needle such as 20mm length needle. We bend the tip side of the needle to submerge the tip into water. By using this setting, Daphnia could approach to the balloon, thrust the needle into the balloon, and destroy the balloon. An example of the balloon destruction experiment is shown in Fig.1.

Figure 1: An example of the balloon destruction Experiment by needle installed Daphnia magna.

We next tried to make medical fluid injection task by using Daphnia. After so many trial and errors, we set an injector on Daphnia's back like Fig.2 setting. This injector installed Daphnia can pierce a needle tip into gel and pour fluid into gel.

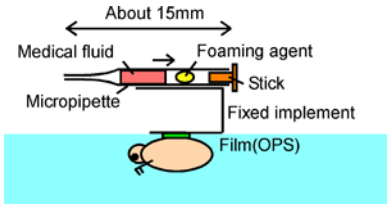

Figure 2: An equipment scheme of an injector.

Discussion

We verified that if we make special tools for microorganism, the microorganism can do special tasks that microorganism itself can never do. Special tools will enlarge the applicability so much. To apply Daphnia to the practical task, however, we have to improve the tools so much.

The size of Daphnia is a bit too large for the micromachine. There are some small water flea such as Bosmina and Chydrus. The size of its larva is smaller than paramecium. So we may apply this motion control scheme to the real bio-micromachine.

References

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