Development of End-effector for Sampling-AUV “TUNA-SAND2”

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Abstract

UV requires high autonomy to accomplish various deep-ocean observation missions, and the next AUV is expected to have sampling function of marine benthos, that is, the end-effector to catch and bring back marine creatures. However, sampling is not easy task for AUV as the shape, size, motion of targets differs. One of the effective end-effectors is the slurp-gun type device to absorb the target with water. In this research, we had developed a sampling device for deep-ocean observation and sampling AUV, Sampling-AUV TUNA-SAND2 in order to inspection of marine ecosystem.

Keywords: AUV, Sampling, End-Effector.

1. Introduction

In recent years, marine survey and development has been carried out in various fields for the purpose of mineral resources, sea floor biological sampling etc. A wide variety of organisms live in the vast ocean and it can be said that the ocean is the largest biosphere on Earth with diverse organisms ranging from microorganisms to whales and huge algae. Investigation of the deep ocean and ecosystems has big contributions for elucidation of biological diversity such as ensuring marine life, predicting ecological changes after marine resource mining, biological strains, and life history. The ocean around Japan is the one of most biodiversity area in the world, which is an irreplaceable resource of Japan.

In this research, we will develop a sampling device of underwater robot for collecting living organisms for the purpose of technical contribution to investigation of ecosystem in the deep ocean floor. In order to elucidate the diversity of marine life, biological sampling is planned using an autonomous underwater robot!-6 (hereafter AUV). However, sampling by AUV is

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different from the remote-operated underwater robot (hereafter ROV), fine operation by human and marine surveys without instruction, and the collection of a precise path plan is required. Figure 1 is the histogram to show which kind methods are used for underwater sampling based on JAMSTEC database. As a first step, we studied the suction type capturing method like a slurp gun, and developed a sampling device that can capture small crabs or shells, and propose the combination of slurp gun and gripper for performance evaluation.

![Fig. 1 Classification of sampling method based on JAMSTEC biological database.](image)

**2. Development of Sampling Device**

**2.1. Concept of Device**

The slurp gun developed in this research is a device that brings the nozzle closer to the target object to be aspirated, sucks the sea floor organisms together with the seawater, and preserves the organisms in a storage container called a canister after collection. Figure 2 shows the prototype of Slurp gun.

One of our target benthos is Shinkaia crosnieri, which is a species of squat lobster in a monotypic genus in the family Munidopsidae. The target weight in water is 100g, and size is below 10 cm.

**2.2. Suction Force Evaluation**

The suction force experiment was conducted as performance evaluation of developed sampling equipment. In the experiment, it was investigated whether the target moves to the canister while leaving the nozzle tip a certain distance from the suction target. Then aspirated and up to 10cm while away the distance from the center of the nozzle for each 2cm, to measure the suction force. It was a ping-pong ball (in water weight 10 ~ 100g) as a suction target. Prototype maximum suction amount was 100g. The specifications are follows: Pump power is 90 W, the diameter of nozzle is 9.4 cm, the length of pipe is 1 m, water flow is about 350 litter/sec.

![Fig. 2 The slurp gun prototype for performance evaluation.](image)

The experimental variables are shown in Fig. 3, and the experimental result is in Fig. 4.

![Fig. 3 Experimental condition and parameters.](image)
2.3. Slurp gun with Gripper

Biological capture around the nozzle is important to improve the capture rate of organisms. Therefore, we developed a suction gripper that attracts organisms around the nozzle into the nozzle diameter. Also, it was placed streamlined to suppress the fluid resistance portions attract. Fig. 5 shows the state of the opening and closing of the gripper in, Fig.6 shows the combination of slurp gun and gripper.

The combination of slurp gun and gripper has been successful in suction pulls the suction target of 100g at a distance of a=10 cm from the center of the nozzle, which could not be suction with only slurp gun. The developed end-effector is shown in Fig. 8.

Fig.4 Results of suction force evaluations.

Fig.5 The concept of the gripper.

Fig.6 The combination of slurp gun and gripper.

Fig.7 Results of suction force evaluations with slurp gun and gripper.

Fig. 8 The developed end-effector.
3. Conclusions

In this research, we developed the sampling device for seabed biological sampling and evaluated its performance. It is assumed that the undersea organism is assumed to be close to the neutral buoyancy, therefore the developed end-effector has sufficient suction power for undersea biological collection. Aspiration around the nozzle which was difficult with conventional slap gun was also possible by attaching gripper. As a result, capture of living organisms is improved and harvesting is expected.

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References


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