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Abstract

In order to improve the efficiency of the seafloor survey, it is necessary for AUV to report the state of the seafloor to the operators on board reasonably. We have been developing seafloor image selection and image compression technology for the seafloor image transmission using the underwater acoustic communication device. In this paper, we report the results of underwater image selection and transmission in biological sampling experiments conducted in November 2019 off the coast of Suruga-bay, Shizuoka, Japan.

Keywords: underwater image processing, sampling-AUV, image selection, field robot, seafloor survey.

1. Introduction

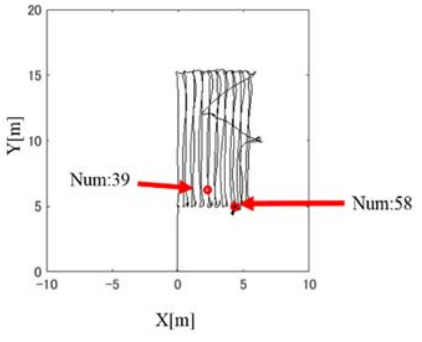
m the viewpoint of marine biodiversity conservation, it is important to improve marine survey techniques. Autonomous Underwater Vehicle (AUV) has enough advantage in the task of observing a wide range area [1-3], however, it is difficult to achieve a task that requires high adaptability and recognition such as biological sampling. In order to improve the efficiency of the survey, it is necessary for AUV to report the state of the seafloor to the operators on board reasonably and in real time. In order to realize such new seafloor observation, the seafloor image transmission using the underwater acoustic communication device is the one of the solutions. We have been developing seafloor image selection and image compression technology for acoustic transmission [4, 5]. In this paper, we report the results of underwater image selection and transmission in biological sampling experiments conducted in November 2019 off the coast of Suruga-bay, Shizuoka, Japan.

2. Mission and underwater image transmission

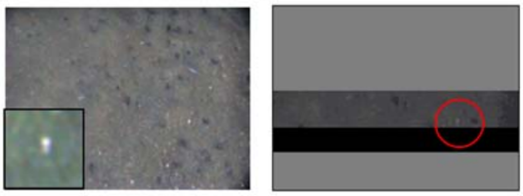
An outline of the mission for sampling Benthos are described. Missions of sampling-AUV are mainly divided into the observation phase, return phase, tracking phase, and sampling phase. Sampling-AUV operates in different modes in each phase. Sampling-AUV comprised of a suction device, a vision system, an acoustic communication system for image transmission, and a hovering-type AUV "Tuna-sand2"[6]. In observation mode, the sampling-AUV moves while maintaining a constant altitude. It photographs the seafloor with a downward camera. The vision system selects an image with an interesting object and compresses the image. The compressed image is transmitted to the ship using the acoustic communication system (see [4, 5] for details). In the return mode, the operator on the ship specifies the selected image including the sampling target. The robot moves to the location where the selected image was taken. In the sampling mode, the robot performs image-based object tracking and sampling of an interesting object.

3. Field Experiments and results

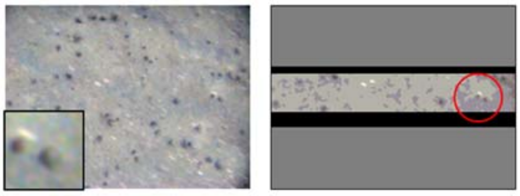
We conducted biological sampling experiments in November 2019 off the coast of Suruga-bay, Shizuoka,



(a)



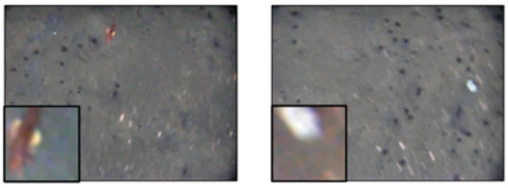
Selected Image Number : 39



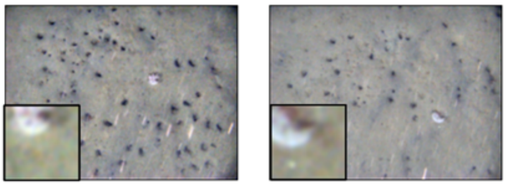
Selected Image Number : 58

(b) (c)

Fig. 1 Results of the first dive (a) Robot trajectory and image capturing position (b) selected images (c) received images.



Selected Image Number : 9 Selected Image Number : 37



Selected Image Number : 50 Selected Image Number : 55

Fig. 2 Selected images not received on board (first dive).

Japan. In this paper, we report the results of image selection and acoustic communication of three trials. Fig. 1 shows the result of the first dive. A total of 62 images of interest were acquired. At the first dive point, the robot captured various underwater objects. However, few selected images were received on board the ship (Fig. 2). At the second dive point, the robot shot the creatures on the seafloor as shown in Fig. 3. Many of the received images selected marine snow (the middle image in Fig. 3), but received images of marine creature (The bottom image in Fig. 3). In this dive, the robot was able to attempt biological sampling. In the third dive, many images selected marine snow more (Fig. 4). The robot also selected creatures (Fig. 5), but no captured images of the creatures were received on board.

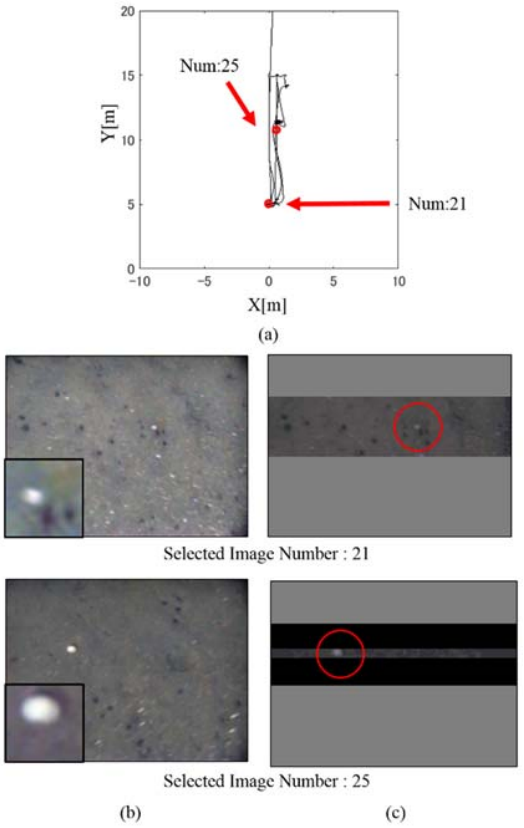


Fig. 3. Results of the second dive (a) Robot trajectory and image capturing position (b) selected images (c) received images.

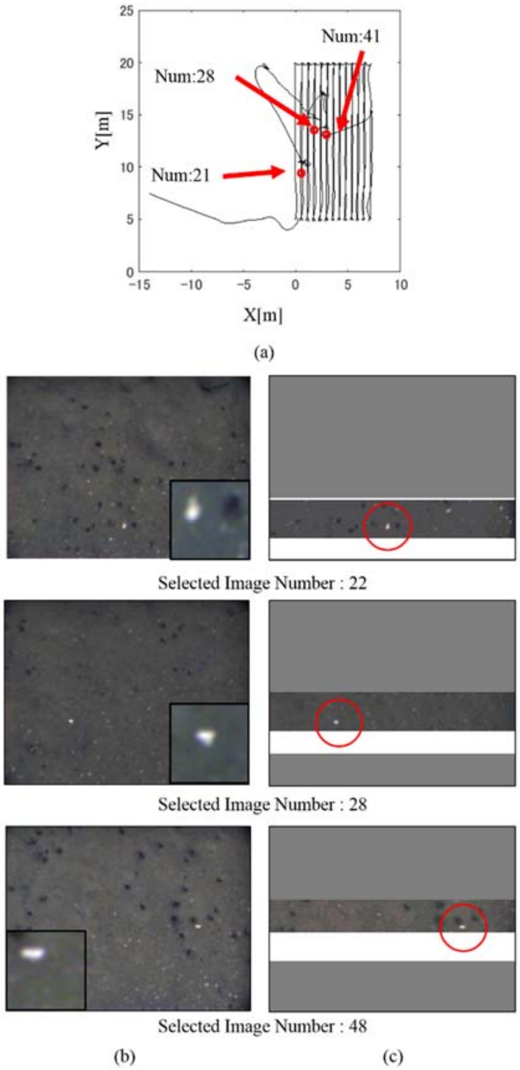


Fig. 4. Results of the third dive (a) Robot trajectory and image capturing position (b) selected images (c) received images.

Fig. 5. Selected images not received on board (third dive).

4. Conclusion

We reported on three field experiments in Shizuoka in November 2019. Underwater creatures were selected by the vision system, but marine snow was often selected. It is difficult to distinguish between marine snow and living things by the image selection algorithm using visual attention based on the conventional bottom-up approach. Therefore, as a future work, we will develop an image selection algorithm that adds a top-down element.

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