Development of Subsea Creature Monitoring Station for AUV Exploration Assistance

著者	Watanabe Keisuke, Utsunomiya Koshi, Sadiq Amir, Hiramaki Daichi, Takashima Kyoko, Ishii Kazuo
journal or publication title	Proceedings of International Conference on Artificial Life & Robotics (ICAROB2020)
volume	25
page range	175-178
year	2020-01-13
URL	http://hdl.handle.net/10228/00008219

doi: https://doi.org/10.5954/ICAROB.2020.OS23-3

Development of Subsea Creature Monitoring Station for AUV Exploration Assistance

Keisuke Watanabe
School of Marine Science and Technology, Tokai Univ., 3-20-1 Orido Shimizu-ku Shizuoka, 424-8610, Japan

Koshi Utsunomiya
School of Marine Science and Technology, Tokai Univ., 3-20-1 Orido Shimizu-ku Shizuoka, 424-8610, Japan

Kazumasa Harada
School of Marine Science and Technology, Tokai Univ., 3-20-1 Orido Shimizu-ku Shizuoka, 424-8610, Japan

Amir Sadiq
School of Marine Science and Technology, Tokai Univ., 3-20-1 Orido Shimizu-ku Shizuoka, 424-8610, Japan

Kazuo Ishii
Center for Socio-Robotic Synthesis, Kyusyu Institute of Technology, 2-4 Hibikino Wakamatsu-ku Kita-Kyusyu, 808-0196, Japan
E-mail: keisuke@tsc.u-tokai.ac.jp, ishii@brain.kyutech.ac.jp
www.scc.u-tokai.ac.jp/~keisuke/index.html

Abstract

In this paper, we introduce our recent result on developing a low cost monitoring station. This station is intended to monitor underwater images of subsea creatures wirelessly from a boat in advance before an exploration AUV is put into water. We describe the concept, the design and system integration of the station in the paper. We also present an experimental result that was carried out to test the implemented functions at Suruga bay at 65m water depth.

Keywords: Subsea creature monitoring, Independent device, Real time monitoring, AUV assistance, Field experiment.

1. Introduction

As the global climate change is ongoing, ocean environment seems also changing rapidly[1] and it is often said that this change damages ocean eco system, which impacts variety of creatures. For example, coral bleaching is progressing worldwide and it becomes a big issue for people in those area because their food supply or economic activity like tourism is being damaged. In Suruga bay in Shizuoka prefecture, a unique shrimp called “Cherry shrimp” was very famous and very important income resource for fishermen. However, recently the amount of this shrimp catch decreases rapidly, whose cause has not been found clearly because no data accumulation underwater has been tried.

Considering these background, we are developing a set of sea creature investigation systems which consists of

AUVs, a support vessel and subsea monitoring stations[2]. In this paper, we introduce our recent result on developing a low cost monitoring station. The similar real time monitoring system using underwater camera has been developed and used effectively by biologists, for example, as shown in the Ref 3. Our station is cheaper and intended to monitor underwater images of subsea creatures wirelessly from a boat in advance before an exploration AUV is put into water. As AUV images cannot be checked until it returns, we need information where we should put an AUV. The station consists of a cage on the seabed, a float which relays underwater images to a support vessel and an umbilical cable from the cage to the float. We describe the concept, the design and system integration of the station in the paper. We also present an experimental result that was carried out to test the implemented functions at Suruga bay at 65m water depth.

2. The system concept

We have carried out many sea experiments to try to catch sea creatures for the purpose of investigation of underwater environment using the AUV "Tuna Sand 2" at Suruga bay for these years[4,5]. "Tuna Sand 2 (TS-2)" can send compressed subsea pictures from underwater to the surface support vessel through ultrasonic acoustic communication link. However, through our experience, we found lower cost underwater survey system in advance of diving TS-2 is effective. As the weight of TS-2 is around 400kgf, so its deployment from our support vessel on the sea is not an easy task, whereas sometimes the diving area found not abundant after TS-2 came back. It is a kind of AUV drawback that we cannot monitor its surrounding situation until it comes back and we transfer images from it. To make AUV performance more efficient, we need to know underwater image in advance whether the area is worth diving with the AUV.

The schematic view of our concept is shown in Fig.1. As shown in Fig.1, the device consists of two main parts of a float and a subsea camera module. On the float, a wireless LAN module is put so that a researcher on the support vessel can monitor the real time subsea images. We decided to put a cage on the seabed to collect sea creatures using bait. This cage is also an anchor weight and a structure where cameras and lights are attached. The cameras are wired to the float so the wire must be strong enough to bear its tension as well as connectors must be bearable to the tension by the wire. The mechanical design which is applicable to sea experiments is very important considering its handling such as throwing or collecting on the rolling vessel as well as ocean current which drags the cable.

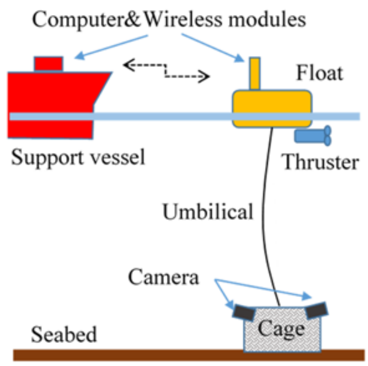

Fig.1. Schematic view of the monitoring system concept.

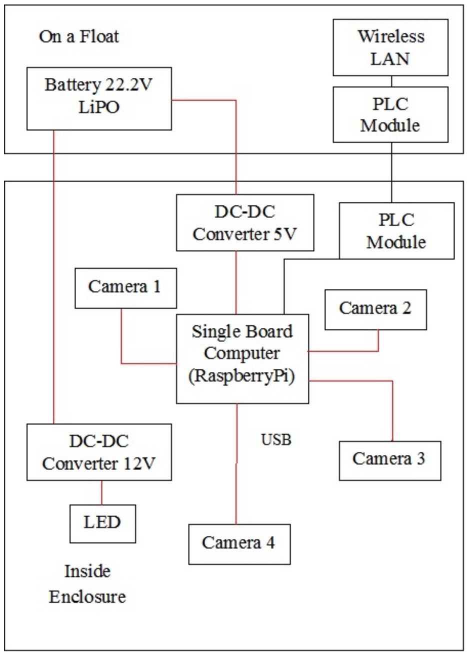

Fig.2. System architecture and devices.

3. The system architecture

The system architecture is shown in Fig.2. As the size of the pressure hull is limited, we designed the battery is arranged on the float. The length of the power and signal

cable is around 100m and its resistance becomes around 3Ω. The maximum current is more than 2A only when the board computer starts but after that the current becomes less than 1A. Considering the voltage drop at the end of the cable and current fluctuation, the DC-DC was selected to allow wide range input voltage.
Four cameras were installed. One camera is facing to the sea bottom and the others are facing horizontally at each vertex of equilateral triangle as shown in Fig.3 and Fig.4. Each camera image can be monitored through LAN signal from the board computer through PLC modules.
LED module is shown in Fig.3. LED module is arranged near each camera respectively. It can be turned on/off from the PC on board.

4. Sea experiment

Sea experiment was carried out on 16th December 2019. The experimental site is shown in Fig.5. Tokai Univ.'s research vessel "Hokuto" is deployed for this experiment. Fig.6 shows the cage, the cable and the float. The cage is suspended from the vessel using a rope to support tension. While the cage is descending, we pay out the cable with handling not to exert tension to the cable. The float is released finally from the vessel, then the vessel can be away from the monitoring device with no fear of winding the cable or wire into its thruster, which makes the operation safer.
Fig.7 shows the structure of the cage. The cage has opening to lure creatures. The bait is put on its lower floor and the cage has a structure that once a creature is coming into the bait floor it is not easy for the creature to go back to its entrance.
Fig.8 shows LED in the pressure hull attached to the cage. This picture was taken by an action camera which is set inside the cage.
Fig.9 shows the captured images of four cameras' video after the cage was reached on the seafloor. We confirmed some planktons like krill near the seabed real time on board as shown in Fig.9.

5. Summary

We designed and developed a low cost monitoring station as a prototype. We succeeded to monitor real time underwater image on board. In this experiment, we found the drag force of the cable is very strong as is considered before the experiment. The cable length was fixed as

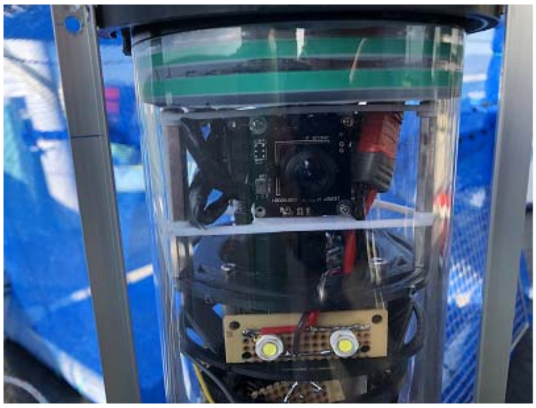

Fig.3. Horizontal camera

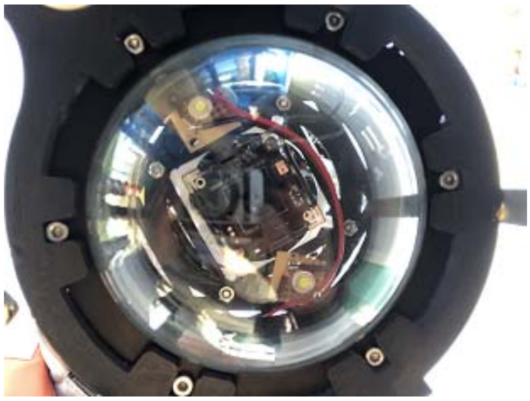

Fig.4. Horizontal camera

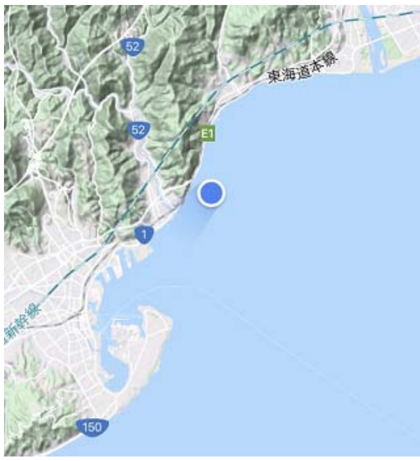

Fig.5. Site of sea experiment

Fig.6. The cable, cage and float.

Fig.7 The cage includes bait.

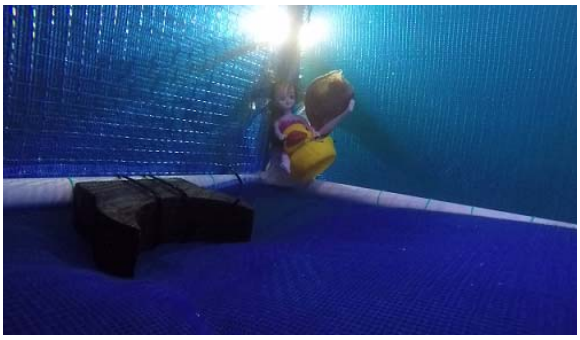

Fig.8. Bottom camera

around 100m and considering its curved shape, the water depth 65m was selected. We need to improve to be able to change the cable length according to the water depth. This time the cable was pulled out due to strong current.

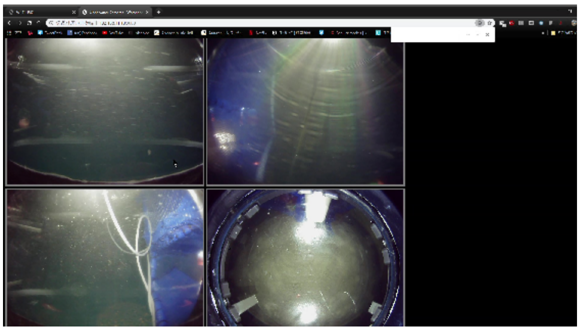

Fig.9. Bottom camera

So the experiment time was not enough to catch creatures. In our next work will be the float should be modified to an autonomous surface vehicle and the cage should be modified to a subsea crawler, which enables longer investigation and monitoring at deeper site.

Acknowledgements

The authors deeply grateful to Captain I.Hashigaya and Chief engineer H. Sakata of Tokai Univ's research vessel HOKUTO as well as those students of our laboratory who helped the experiment, K. Kitazawa, D. Hiramaki. Part of this work was supported by JSPS KAKENHI Grant Number 18K04585.

References

1. W.W.L.Cheung, R. Watson and D. Pauly, Signature of ocean warming in global fisheries catch, *Nature,* Vol. 497, 2013, pp.364-369, doi:10.1038/nature12156
2. K. Watanabe, K. Mitsumura, K. Utsunomiya, K. Harada, An Experiment of Multi-copter and Small ROV Combined Monitoring System for Coastal Area Environment, Proc.of *the 28th International Ocean and Polar Engineering Conference,* 2018, pp.373-378
3. D. J. Mills , G. Verdouw and S. D. Frusher, Remote multi camera system for in situ observations of behavior and predator/prey interaction of marine benthic macrofauna, *New Zealand Journal of Marine and Freshwater Research*, 2005, Vol.39(2), pp.347-352, DOI:10.1080/00288330
4. Y. Nishida, T. Sonoda, S. Yasukawa, J. Ahn, K. Watanabe and K. Ishii, Benthos Sampling by Autonomous Underwater Vehicle Equipped a Manipulator with Suction Device, *IEEE Xplore Underwater Technology*, 2019, DOI10.110/UT.2019.8734330
5. S. Yasukawa, Y. Nishida, J. Ahn, T. Sonoda, K. Watanabe and K. Ishii, Development and Sea Trials of Vision-Based Control for Sampling-AUV, *IEEE Xplore Underwater Technology*, 2019, DOI10.110/UT.2019.8734462