南極探査用AUV"MONACA"の運用計画と設計
Operation plan and design of the Antarctic exploration AUV "MONACA"

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Autonomous Underwater Vehicles (AUVs) have been used for under-ice explorations of the Antarctic Ocean. Most of the current under ice AUVs are large and are used for the long-distance survey. Survey results of these AUVs are extremely precise, but there is a trade-off between precision and running cost and/or risk of losing AUVs.

In this presentation, the authors propose a variable and compact AUV MONACA (Mobility Oriented Nadir AntarctiC Adventurer) which can offer the necessary and sufficient compositions for various survey needs by the modular design. Development of MONACA is supported by JSPS Grant-in-Aid for Scientific Research on Innovative Areas No.4902, to measure the sea ice/shelf ice and ocean floor for research of ice sheet-ocean interaction.

MONACA is 2 m long, 230 kg weight, and it can cruise for about 8 hours. Depth rating is 1500m. The vehicle is designed to go into ice-covered oceans as far as 10 km. The flat body is filled with buoyancy materials at the top so that the battery units and main unit can be accessed from the side. The vehicle has five degrees of freedom (surge, heave, roll, pitch, and yaw) by 4 vertical thrusters and 2 horizontal thrusters. Although the survey range is limited compared with large AUVs, it can conduct a highly precise survey with lower costs.

The three missions are considered as shown in the figure. (A: Seafloor tracking, B: Ice tracking, C: Water survey in constant depth). In the missions A and B, the shape of the seafloor or the ice is mapped by a multi-beam sonar while tracking it by a probabilistic approach using a scanning sonar. The multi-beam sonar measures 480 points in the swath width of 120˚. The vehicle has two set of releasable ballasts for diving and surfacing. The vehicle is designed to follow the seafloor or ice at the reference altitude of 50 m. In the mission C, the vehicle navigates at a constant depth, measuring water quality by a CTD sensor. Resolution of the CTD sensor is Temperature = +/- 0.0001 ˚C, Conductivity = +/- 0.0001 mS / cm, Depth = 0.03 m.

In order to realize these three missions under the size limitation, MONACA has the sensor unit that can be flipped upside down. The sensor unit includes the multi-beam sonar, an INS, and a DVL. Therefore, MONACA can navigate only by the sensor unit in case there are no obstacles in the seafloor.
MONACA is currently under construction, to be launched in 2019.

キーワード：南極、AUV
Keywords: Antarctic, AUV