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Disk-type Underwater Glider for Virtual Mooring and Field Experiment

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In recent years, it has become evident that ocean data in time and space are required to make predictions of environmental changes on Earth. As a method of acquiring data, we propose a virtual mooring system using an underwater vehicle, and we have developed a vehicle which will glide back and forth between the sea surface and the seabed collecting ocean data. This paper presents the developed vehicle and its field experiment.

INTRODUCTION

In recent years, predictions of changes in the environment on Earth and studies on ecodevelopment have both become important. Such research requires ongoing ocean data in time and space, and these have been obtained using mooring systems. However, a conventional mooring system can observe only discrete data in perpendicular space; further, construction of such a system requires manpower and great expense. To solve this problem, an underwater vehicle for virtual mooring is being constructed at the Research Institute for Applied Mechanics, Kyushu University.

Fig. 1 shows the concept of virtual mooring using an underwater vehicle that houses various pieces of observation equipment; the vehicle glides back and forth between the sea surface and the seabed collecting ocean data. When the vehicle returns to the sea surface, the measured data are transmitted to a research base by a mobile phone. The vehicle then automatically checks its current position by GPS. If the position is outside the sea area of virtual mooring because of currents etc., the vehicle is controlled so that it returns to the previous area during its next dive. The control method is described in detail below. Diving and surfacing are repeated periodically. On the seabed, the vehicle rests for a predetermined period, and power other than control equipment is shut off in order to cut down on battery consumption. Horizontal movement of the vehicle is done with gliding and without thrusters (Murakami, 1973; Greenan and Oakey, 1999; Eriksen, Osse, Light, Wen, Lehman, Sabin, Ballard and Chiodi, 2001; Leonard and Graver, 2001; Sherman, Davis, Owens and Valdes, 2001; Webb, Simonetti and Jones, 2001; Woolsey and Leonard, 2002; Fiorelli, Bhatta, Leonard and Shulman, 2003; Rudnic, Davis, Eriksen, Fratantoni and Perry, 2004; Paley, Zhang and Leonard, 2008; and Seo, Gyungnam and Choi, 2008). The gliding ratio and the course of the vehicle are controlled by moving the position of the built-in weight

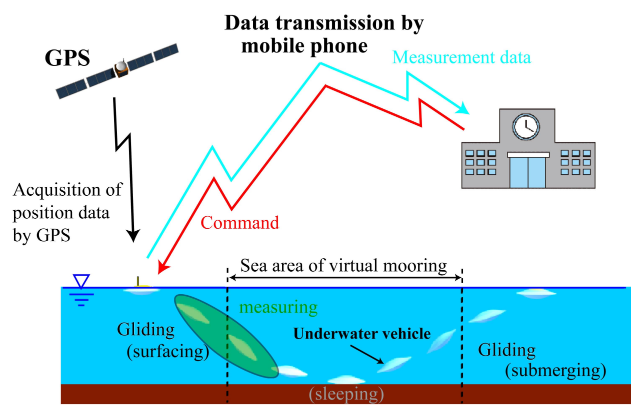

Fig. 1 Concept of virtual mooring—outline of disk-type underwater glider *Boomerang*

Depth is controlled by buoyancy adjustment equipment, as shown in the same figure (Nakamura, Hyodo and Koterayama, 2007). The body form is of the disk type, which is characterized by omni-directional maneuverability. The vehicle can directly glide in any direction by piloting the built-in moving weight, making a turnaround like that of a conventional airplane unnecessary. In ISOPE-2007 (Lisbon), we presented motion simulations of the vehicle for virtual mooring and the outline of the testbed (model) vehicle *Luna* (Fig. 4) for study on control (Nakamura, Hyodo and Koterayama, 2007). In this paper, we report on the full-scale vehicle, which has been developed as *Boomerang*, and the field experiment results.

Fig. 2 shows the principal dimensions of *Boomerang*; Fig. 3, a drawing of the general view and a photograph of the loading apparatus. Final examination and observation are scheduled to be carried out in the Eastern Channel of the Tsushima Strait.

The maximum diving depth of the vehicle is 100 m, and the body diameter is 1900 mm in consideration of the capacity required for loading apparatus, maintenance (a hand reaches easily to the center of a vehicle), transportation (no specific transporter is necessary), etc. The hull is made from FRP and carried within it are the sensor for motion control (GPS, magnetic compass, roll sensor, pitch sensor, depth sensor), buoyancy adjustment equipment, weight shifter, electric device, battery, and the mobile phone

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KEY WORDS: Virtual mooring, underwater vehicle, gliding, control, field experiment.