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"LUNA" Testbed Vehicle for Virtual Mooring

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ABSTRACT

In recent years, predictions of changes in the environment on earth and studies on ecodevelopment have become important. For this research on going ocean data in time and space is required, and has been obtainable using by mooring systems. However, a conventional mooring system can observe only discrete data in perpendicular space and moreover, construction of such a system requires a manpower and great expense. To solve this problem, an underwater vehicle for virtual mooring has been developed at Research Institute for Applied Mechanics (RIAM). The vehicle glides back and forth between the sea surface and the seabed collecting ocean data, with direction control regulating the vehicle's position in a designated area.

This paper describes the testbed vehicle "LUNA" that was designed to develop a virtual mooring system, and the control algorithm is discussed.

KEY WORDS: Virtual mooring; underwater vehicle; motion simulation; control; tank test

INTRODUCTION

The concept of virtual mooring using an underwater vehicle is shown in Fig.1. The vehicle that houses various observation equipment dives to the seabed where it carries out virtual mooring. When the vehicle returns to the sea surface, the measured data is transmitted to a research base through an artificial satellite. The vehicle then automatically checks its current position by GPS. If the position is out from the virtual mooring ocean space because of currents etc., the vehicle is controlled and again dives to return the previous area. The vehicle repeats diving and surfacing periodically. On the seabed, the vehicle rests during the set period and power supplies other than control equipment are shut off. The gliding ratio and the course of the vehicle are controlled by moving the position of the built-in weight (see Fig.27, Fig.29 and Fig.31). The depth of the vehicle is controlled by buoyancy adjustment equipment (see Fig.27, Fig.28 and Fig.31).

In this paper, the mathematical model of the underwater vehicle (disc-type glider) for virtual mooring, hydrodynamic coefficients of the vehicle, tank tests on gliding performance, motion simulations and the outline of the testbed vehicle "LUNA" are shown.

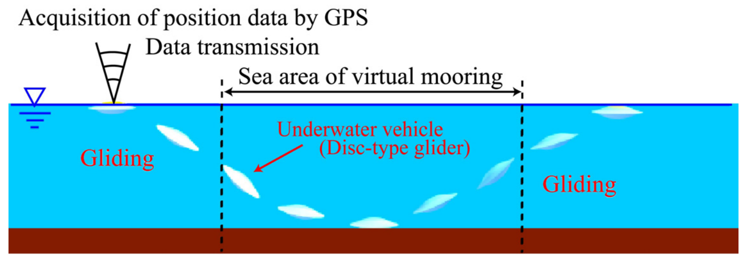

Fig. 1 Concept of virtual mooring

MATHEMATICAL MODEL

The vehicle body form used is a disk type, and it is characterized by not having directivity. The vehicle can glide in various directions by moving the built-in weight. The coordinate system used to describe the motion of the vehicle is shown in Fig.2. The equation of motion (Murakami 1973 and Koterayama et al., 1988) is as follows:

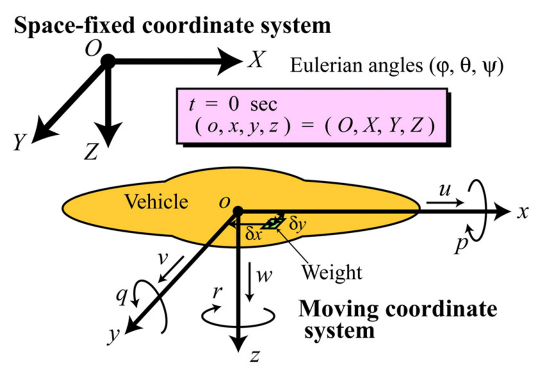

Fig. 2 Coordinate system

$$\begin{bmatrix} m+A_{11} & 0 & 0 & 0 & m z_G & -m y_G \\ 0 & m+A_{22} & 0 & -m z_G & 0 & m x_G \\ 0 & 0 & m+A_{33} & m y_G & -m x_G & 0 \\ 0 & -m z_G & m y_G & I_{xx}+A_{44} & 0 & 0 \\ m z_G & 0 & -m x_G & 0 & I_{yy}+A_{55} & 0 \\ -m y_G & m x_G & 0 & 0 & 0 & I_{zz}+A_{66} \end{bmatrix} \begin{bmatrix} \dot{u} \\ \dot{v} \\ \dot{w} \\ \dot{p} \\ \dot{q} \\ \dot{r} \end{bmatrix} = \begin{bmatrix} F_x \\ F_y \\ F_z \\ M_x \\ M_y \\ M_z \end{bmatrix} \tag{1}$$