Development of a Supplementary Outboard Side Thruster System for Dynamic Positioning Control of Autonomous Surface Vehicle

Tetsu Kato*, Yamato Kawamura* and Junichiro Tahara*
Tokyo University of Marine Science and Technology
Tokyo, Japan

Shoichiro Baba
Japan Agency for Marine-Earth Science and Technology
Kanagawa, Japan

Yukihisa Sanada
Japan Atomic Energy Agency
Fukushima, Japan

Shun Fujii
Tokyo University of Marine Science and Technology
Tokyo, Japan

We describe the development of a side thruster system that can maintain the heading direction of autonomous surface vehicles (ASVs). At present, the Japan Agency for Marine-Earth Science and Technology, Japan Atomic Energy Agency, and Tokyo University of Marine Science and Technology are jointly working on the investigation of radioactivity in mud deposited in estuaries in Fukushima Prefecture, Japan. The main objective is unmanned mud collection using the ASV. For mud collection, we developed a side thruster system and implemented it to the ASV. We developed a unified main and side thruster system for one-man operation of the ASV using a joystick. We confirmed the operation of the ASV with the joystick in field tests.

INTRODUCTION

Radioactive materials were released into the atmosphere during the Fukushima Dai-Ichi Nuclear Power Plant accident in 2011. Several years have passed since the accident, and mud with a high concentration of radioactive materials may be deposited at estuaries and ports in Fukushima Prefecture. Therefore, it is necessary to conduct a mud radiological survey. Hence, the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Japan Atomic Energy Agency (JAEA), and Tokyo University of Marine Science and Technology are jointly working on unmanned mud collection using an autonomous surface vehicle (ASV). Autonomous ships used in oceans, such as ASVs, have been actively studied recently (Peng et al., 2017; Mousazadeh et al., 2018; Peeters et al., 2018; Park et al., 2018; Silva et al., 2018). Dynamic positioning system (DPS) control of the ASV is necessary during the mud collection to prevent the tipping over of the mud collector and kinking of the connecting wire between the ASV and the mud collector.

However, the ASV is not equipped with side thrusters and has no means of controlling its heading. Therefore, we endeavored to solve this problem by developing and implementing a side thruster system. A microprocessor (Arduino) is used to control the thrusters by sending control signals to it via a graphical user interface (GUI) on a PC. It is possible to remotely control the side thrusters using Microsoft Remote Desktop between the PCs in the ASV and at the land station. The configuration of this side thruster system is described in the section on its development. We implemented this side thruster system in the ASV and conducted operation tests at a port in Soma City, Fukushima Prefecture. This location is used as the robot’s experiment field (Kawamura et al., 2019). First, the results of the side thruster bollard test confirmed that the thrust force was obtained as designed. Next, we conducted a turn and parallel movement test of the ASV. As a result, we confirmed that this side thruster enables turning and parallel movement of the ASV. Furthermore, we implemented a mud collector and a winch on the ASV to perform the mud collection test. From the test results, we confirmed no kinking of the wire during the mud collection. Therefore, with this side thruster system, we can maintain the heading of the ASV and prevent kinking of the wire under relatively gentle wave and wind conditions.

Next, we modified the side thruster system to correct the problems of mud collection operation, which were revealed in the mud collection test. First, the main and side thrusters of the ASV can be operated using a joystick to save manpower. Next, we created a power supply system for the side thrusters, which can be powered from the ASV generator. It can supply a stable power source to the side thrusters. In addition, by connecting this ASV communication system and the GPS/inertial measurement unit (IMU) sensor of a μ-ASV (Kawamura et al., 2019), which was developed prior to this ASV, the amount of communication between the ASV and the ground station can be reduced, and the position can be checked on a map in real time.