



R/V Kaiyo Cruise Report

KY13-03

Performance Test of The AUV, *Jinbei*

Sagami-Bay

February 16, 2013 – February 24, 2013

Japan Agency for Marine-Earth Science and Technology
(JAMSTEC)

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1. Cruise Information

Cruise ID: KY13-03
Name of vessel: R/V Kaiyo
Title of the cruise: Performance Test of The AUV, Jinbei
Cruise period: 2013/2/16~2013/2/24
Ports of call: Pier of JAMSTEC ~ Sagami-Bay
Research area: Sagami-Bay (water depth of 80 m ~ 1,500m)
Research Map

Sea-trial was carried out in the area bounded by (34°55.0'N,139°13.5'E), (35°00.0'N,139°06.5'E), (35°14.0'N,139°13.0'E), (35°14.0'N,139°25.0'E), (34°55.0'N,139°25.0'E)

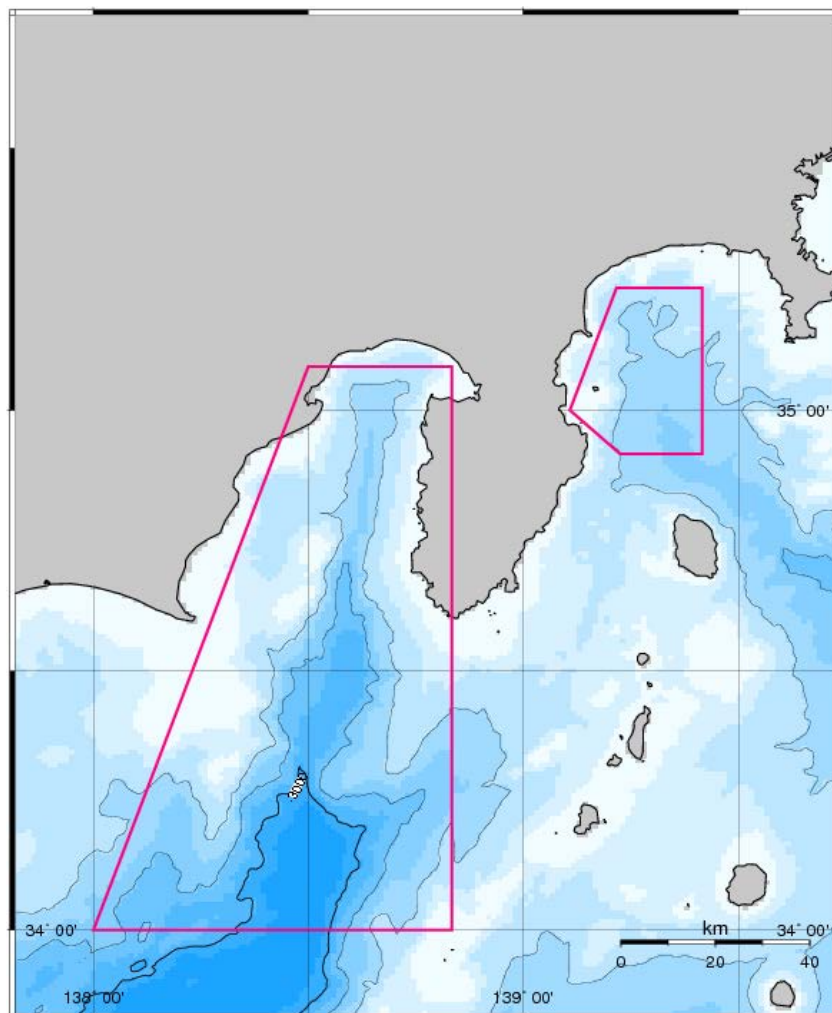


Figure 1 : Test area.

2. Researchers

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Science party (List)

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3. Test Equipment

3.1 Cruising AUV, Jinbei

The cruising AUV named “Jinbei” (4 m long, 2 tons in weight) is developed for research of Earth science, CCS assessment, and exploration of underwater minerals. The AUV is equipped with three main sensors: a multi-beam echo sounder, a side-scan sonar, and a hybrid CO₂-pH sensor. Figure 3.1 and Figure 3.2 show a snap shot photo at a retrieving scene and its device configuration, respectively. The specifications of the AUV are listed in Table 3.1.

Jinbei is equipped with a CTD sensor; SBE49, a dissolved oxygen sensor; RINKO-III, a combination-chlorophyll fluorescence and turbidity sensor; ECO FLNTU(RD), a 120 kHz / 400 kHz side scan sonar; EdgeTech 2200M, a 400 kHz multi-beam echo sounder; SEABAT 7125, and the hybrid pH-CO₂ sensor (HCS) designed by JAMSTEC.



Fig. 3.1: Overview of Jinbei.

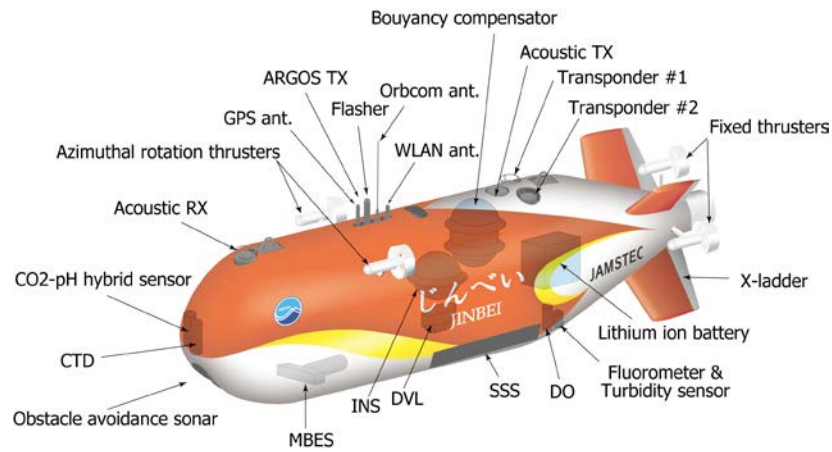


Fig. 3.2: Configuration of Jinbei.

Table 3.1: Specifications of Jinbei

<i>Items</i>	<i>Value</i>	<i>Unit</i>	<i>Remarks</i>
Dimension	4.0 x 1.1 x 1.1	m	
Weight	1.7	t	in air
Working depth	3,000	m	
Endurance	10	hours	
Speed	0.7 ~ 3	knots	2 kt typ.
Propulsions	6 x 400W thrusters		
Sensors	INS, DVL, GPS, SSBL, LBL, VLBL Depth meter, Obstacle avoidance sonar, altimeter		
Scientific payloads	CTD-DO, Fluorometer & Turbidity sensor, pH-CO2 hybrid sensor, Multi-narrow beam echo sounder, side scan sonar		

3.2 Launch and recovery system

A sketch of the new launch-recovery system is shown in Figure 3.3. This prototype system is designed to fit the R/V Kaiyo which is equipped with a large A frame crane. The system consists of a vehicle platform with a raising base which is rotated by a hydraulic cylinder to 90 degrees. The vehicle is hanged from the raising base with a vehicle hanger and arrested to the base with an arresting rope. The vehicle is forced outward by a dumper. If you loosen the arresting rope, the vehicle is pushed out of the base by the dumper. To uncouple the vehicle from the base, the vehicle hanger is hoisting up by the 7 ton crane, and then the hanger has whole of the vehicle weight. After that, the A frame crane moves outward to release the vehicle on the sea surface.

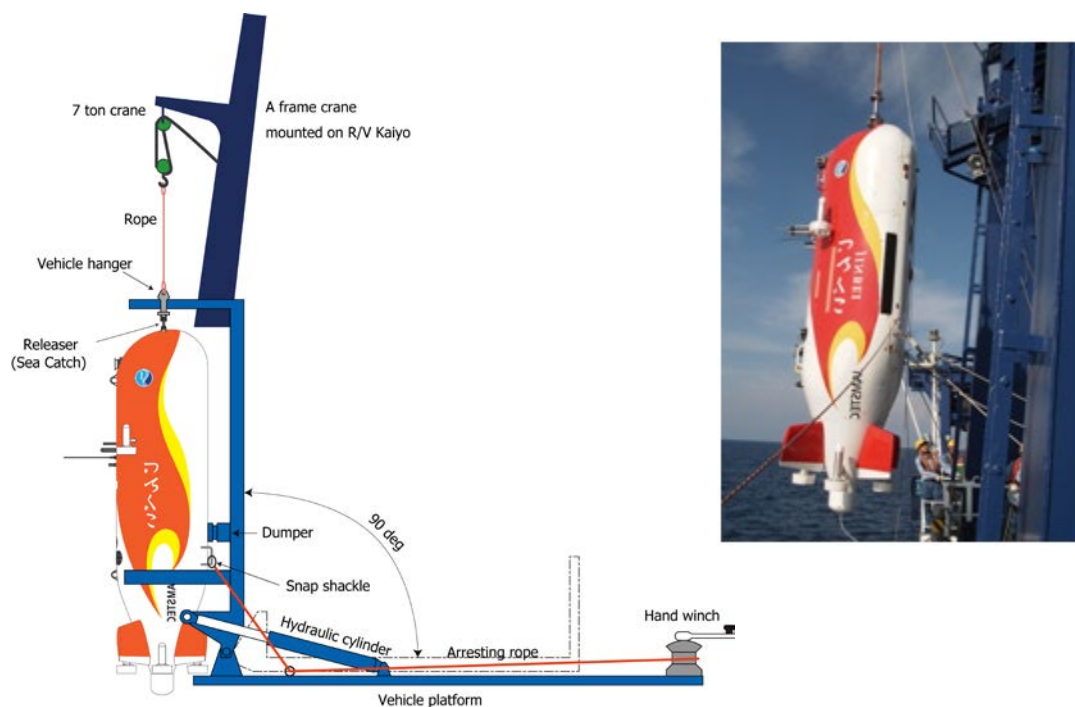


Fig. 3.3: Vertical launcher

3.3 Underwater Recovery System, *RODD*

The RODD (Remotely Operated Docking Device) is an underwater recovery system to catch the AUV in deep sea where effect of surface wave is not suffered. The RODD system consists of the ROV, RODD, a 500 m tether cable, a winch, and a traction control system. The RODD (Table 3.2 and Fig.3.4) equipped with eight thrusters, four cameras, six 40 W LED lights, an ROV homer, a laser scanning system, a depth meter, a MEMS gyro, and a SSBL transponder. This ROV has a carabiner arm to catch the AUV and a rope drum to connect between the AUV and the support ship. The one end of the rope is connected to the carabiner.

Figure 3.5 shows configuration of the recovery system and its operation procedure. After finishing the mission, the AUV come ascent to depth of about 50 ~ 200 m, and then the vehicle stays in its depth. The

RODD approaches the AUV to catch. Once the RODD catches the AUV, a long rope housed in the RODD is connected with the AUV. The RODD is, first, recovered, and the AUV is, then, hoisted up by the on-board winch.

Table 3.2 Specifications of the RODD

<i>Items</i>	<i>Value</i>	<i>Unit</i>	<i>Remarks</i>
Length	1.6 x 1 x 1	m	
Weight	320	kgs	
Depth ratings	300	m	Maximum
Actuators	Horizontal thrusters x 4 Vertical thrusters x 4		80 kgf forward 80 kgf upward
Docking devices	Electrical magnets with actuated 3D-basement 180 degree rotating carabiner arm		
Sensors	Depth meter, MEMS gyro ROV homer, Laser scanner, 4 Cameras		



Fig. 3.4 Overview of the RODD

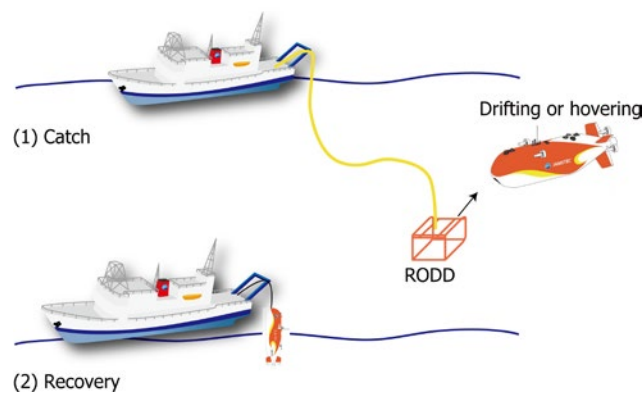


Fig. 3.5 An operation image of the RODD and Jinbei.

4. Test

4.1 Main topics planned

- ① Remote control with the acoustic communication system
- ② Autonomous cruising in case that various combinations of the motion control algorithms
- ③ Scenario cruising monitored by the acoustic communication
- ④ Seafloor observation with the MBES
- ⑤ Underwater recovery test

4.2 Number of dives

Jinbei	2 dives	(Dive# 6 and 7)
The RODD	0 dive	

4.3 Test results

Date	Test Items	Results
Feb. 16 Shinko Pier, Port of Yokohama	● Checking the system of Jinbei ● Checking the system of the RODD ● Training of the launch and recover of Jinbei. ● Training of the launch and recover of the RODD. ● Recovering the HCS and Checking the CTD.	CTD and HCS were NG OK OK OK CTD was out-of-service
Feb. 17 Shinko Pier, Port of Yokohama	● 09:00 JST: leaving the port ● Pre-dive-checking ● Training of the launch and recover of Jinbei. ● Creating and simulating a cruising scenario.	
Feb. 18 Sagami-Bay	● Acoustic communication test by using the new projector equipped with the R/V Kaiyo.	The weather became bad during the test. Acoustic test was good but Jinbei suffered serious hardware damage in the recovering.
Feb. 19 JAMSTEC pier	● Restoration of the damaged parts ● Checking the functions of the repaired parts	Kaiyo was returned to JAMSTEC, Yokosuka to fix the damaged parts. Jinbei was unloaded from the ship.
Feb. 20 JAMSTEC pier	● Fixing the damaged parts ● Reloading Jinbei to the ship	
Feb.21 JAMSTEC pier Sagami-Bay	● Pre-dive-checking ● Adjusting the buoyancy ● 15:00 JST: Leaving the port	

Feb. 22 Sagami-Bay	● Dive #6 in Sagami-Bay. ● Acoustic remote control test ● Vehicle dynamics test	Failed entering underwater two times. The 3 rd try was succeeded but time was up. We did not perform the tests planned because the depth of the dive was only 20 m.
Feb. 23	● Retry of the test (dive #7) ● Acoustic remote control test ● Vehicle dynamics test	Range of the acoustic communication was shorter than range of the design. Vehicle dynamics was good Scenario cruising was done
Feb. 24 Pier of JAMSTEC	● Unloading the system	

4.4 Summary

We did not done all test planned because of the serious damage suffered by the bad weather. In the dive #6, healthiness of the whole system was only checked because the vehicle dove up to depth of 20 meters. In the dive #7, the tests of autonomous cruising and a scenario cruising were performed in depth of about 500 m but the remote control and the monitor by the acoustic communication were not done. The MBES was checked. An underwater recovery test was not tried. We did not have enough time for the tests of all items planned due to the trouble. We need reviews and improvements of the damaged parts.

5. Notice on Using

Notice on using: Insert the following notice to users regarding the data and samples obtained.

This cruise report is a preliminary documentation as of the end of the cruise.

This report may not be corrected even if changes on contents (i.e. taxonomic classifications) may be found after its publication. This report may also be changed without notice. Data on this cruise report may be raw or unprocessed. If you are going to use or refer to the data written on this report, please ask the Chief Scientist for latest information.

Users of data or results on this cruise report are requested to submit their results to the Data Management Group of JAMSTEC.