

特集に際して
Guest Editor

海中工学研究センター特集号

浦 環*

Tamaki URA

沈没船やロケットの引き上げ、大陸棚問題、EEZ 境界付近の海底資源問題、東海・東南海・南海地震発生の可能性、あるいは 11,000 m 深度まで潜ることのできる ROV「かいこう」の亡失など、良くも悪くも海中に関わる話題はつきない。

1999 年 4 月に 10 年の時限にて海中工学研究センターが設立されて半ば 5 年が経過したが、このような背景にあって、センターの旗印のもとに研究活動はますます活発化している。そこで、所属する研究室の最もホットな研究トピックスを集めて特集号を組み、海中工学の最先端を紹介しようと考えた。

2004 年 11 月現在、センターは次の 5 つの研究室から構成されている。

- ・浦 研究室：海中ロボット学
- ・浅田研究室：海洋音響システム工学
- ・高川研究室：海中海底工学（客員）
- ・林 研究室：海洋環境工学
- ・藤井研究室：海中工学研究センターバイオメカトロニクス

このうち、浅田研（2000 年 4 月発足）以外は設立当初からの研究室である。また、

- ・浅川研究室：海中工学計測学（客員：1999 年 11 月～2002 年 5 月）
- ・Bahl 研究室：海中信号処理工学（客員：2002 年 7 月～2004 年 7 月）

が客員教授の研究室として活動をおこない、センターの研究の幅を広げた。

海洋工学における研究分野は広く複雑多岐にわたっている。本センターでは、自律型海中ロボットの研究開発を柱に据えて、広く海中環境全体を考えていく、という視点により研究室が構成される。このようなシステムは他に類を見ないものであり、他の組織ができない新しい研究分野を

切り開いていく可能性を持っていると自負するところである。

2000 年、2002 年には、センター主宰による国際会議「International Symposium on Underwater Technology」を開催。同国際会議は、2004 年 4 月には台湾で開催され、また、2004 年 11 月の神戸での国際会議「OCEANS/Techno-Ocean 2004」へと発展している。これらの国際会議は、生研国際シンポジウムとして開催され、高い評価を得ている。他の多くの方々にも、本特集号により海中工学研究の次の時代を想像していただきたいと思う。



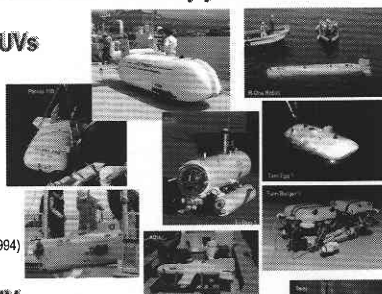
OCEANS/Techno-Ocean 2004 での
海中工学研究センターの展示ブース

*東京大学生産技術研究所 海中工学研究センター長

Underwater Robotics and Application Lab.

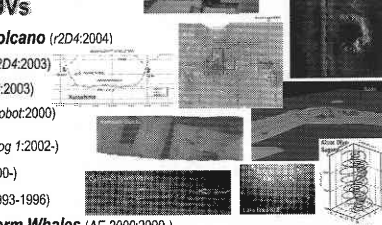
Development of AUVs

- Ocean Going Full-Scale Models
- r2D4** (2003)
- R-One Robot** (1995)
- Pteroa 150** (1989)
- Robust Towed Vehicles
- Tam-Egg 1** (2003)
- Tri-Dog 1** (1999)
- Compact Lake Survey Vehicle
- Tantan** (2000)
- Versatile Towed Vehicle
- Twin-Burger** (1992, 1994)
- Glider
- Albac** (1992)



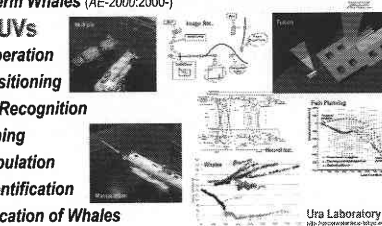
Deployment of AUVs

- Seabed and Water Column Survey
- Rota Underwater Volcano** (r2D4:2004)
- Kuroshima Knoll** (r2D4:2003)
- Off-Sado Fault** (r2D4:2003)
- Teisi Crater** (R-One Robot:2000)
- Survey of Man-made Structure
- Kanaishi Port** (Tri-Dog 1:2002-)
- Water Pollution Survey
- Lake Biwa** (Tantan:2000-)
- Water Column Survey
- Sagami Bay** (Albac:1993-1996)
- Whale Following
- Humpback and Sperm Whales** (AE-2000:2000-)



Intelligence of AUVs

- Multiple-Vehicle Operation**
- Data Fusion for Positioning**
- Underwater Image Recognition**
- Optimal Path Planning**
- Autonomous Manipulation**
- Neural Network Identification**
- Search and Identification of Whales**



Ura Laboratory
ura@urcl.u-tokyo.ac.jp

OCEANS/TECHNO-OCEAN'04, Nov. 10-12, 2004, Kobe, Japan

Asada Lab.
Underwater Acoustic Systems Engineering

Asada Lab. develops software and instruments for underwater acoustic surveys.

Activities

- 01: Centimeter level seafloor geodetic observation system to reveal mechanism of huge earthquakes occurring along ocean trench regions.
- 02: Software supporting for 3D ship navigation with total information system.
- 03: Synthetic aperture and interferometric side sonar mounted on AUV (r2D4) to get fine shape of deep seafloor.
- 04: Multi-frequency sonar system to identify hard-to-distinguish fishing mid layer near seafloor.
- 05: 3D real-time visualization software for fish linking system.
- 06: 3D mapping of seagrass beds with multi acoustic sonar systems.
- 07: Underwater acoustic surveying and surveying systems with Dual Frequency Identification Sonar "DIDSON".
- 08: High resolution monitoring of dam sedimentation with leading-edge multibeam echo sounder.

Asada Lab.
Underwater Technology Research Center
Institute of Industrial Science
University of Tokyo
Professor: Dr. Akira Asada
Research Staff: Dr. Jun Hata, Dr. Shigeru Yamamoto, Dr. Zengo Yoshida

RHEEM LAB

Ocean Environmental Engineering Laboratory

<http://seasid.ais.u-tokyo.ac.jp/rheem/>

Sea Surface Measurement by Active Microwave Remote Sensing

The sea surface intensely fluctuates spatiotemporally by wind, waves and currents. It is very difficult to obtain such information widely on the method for direct measuring of sea surface. In this research, sea surface measurement technique by using active microwave remote sensing is being developed.

Sea Surface Information
Wind, Waves and Currents

Water Surface Profile
Water Particle Motion on free Surface

Sea Surface Measurement by Active Microwave Remote Sensing

Microwave Scattering
Scattering Strength
Doppler Spectrum

Microwave Scattering Measurement System

A system to measure the microwave backscattering from compound water surface by wind, waves and currents in a water mass.

Numerical Simulation of Microwave Scattering at Sea Surface by Surface Current Method

Incident waves
Scattering waves
Reflecting waves

Oil Spill Simulation in Ice Covered Sea

Oil spill in an ice covered sea gets behind in flow, then the identification and the salvage of oil spill is very difficult. Oil spill moves with flow, and widens. The salvage needs long time, and meanwhile, the influence to give to environment of a peripheral sea area is immeasurable. A numerical simulation model of oil spill in an ice covered sea has been developed.

concentration
0 day
1 day
2 days
7 days
14 days
28 days

Underwater Technology Research Center
Institute of Industrial Science
The University of Tokyo

Microfluidic Devices for in situ Biological and Chemical Measurement

Tatsuhiko Fukuba, Naoya Takagi, Masayuki Matsunaga, and Teruo Fujii
Underwater Technology Research Center,
Institute of Industrial Science, University of Tokyo, 4-6-1 Komaba Meguro-ku Tokyo, 153-8505, JAPAN

Bringing microfluidic devices into deep-sea?

Microfluidics is among the emerging technologies that enable us to achieve high-dimensional and high-resolution biological and chemical measurement with reduced amount of sample and reagents. By integrating the concepts for in-situ sensor, optical detection, and even for fluid control into a microfluidic system, an in-situ analytical system can be realized to monitor biological and chemical activities in deep-sea environments. The technology could bring an advantage features such as: 1) an in-situ analysis with specific-spatial resolution, 2) reduction in the problems with sample volume (especially in such cases: 1) small amount of required samples, 2) complicated processes, 3) biological/chemical combined analysis, and 4) compact-sized systems) to be applied mainly on the exploratory vehicle.

The devices - 1) Flow-through PCR device

a) Principle
b) Structure of the device
c) Integrated system
d) Results

The devices - 2) Metal ion (Mn²⁺) analysis device

a) Analytical procedure
b) Microfluidic device
c) Channel patterns
d) Off-line column
e) Measurement curve

Future perspectives

The devices introduced here are now being tested in the deep-sea environment, and thus was recognized especially for the microfluidic measurement for deep-sea biological field by 6th IANM and 6th IANM. The construction of the actual in-situ analytical system for ocean testing and deployment is scheduled in 2002 through 2004. Though there are still many issues to be solved, the microfluidics has tremendous potential to enhance the capability of biological and chemical sensors in deep-sea environments.

Acknowledgements

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Prof. Teruo Fujii
Underwater Technology Research Center,
Institute of Industrial Science, University of Tokyo
fujii@iis.u-tokyo.ac.jp

OCEANS/Techno-Ocean 2004 での海中工学研究センターで展示した 4 つの研究室のポスター