International Symposium on Resource Development in the Ocean

Date : **December 3rd (Thursday)**, 2009 **13:00 ~**

Place: Multi-purpose Meeting Room (601), 6th Floor of RIAM, Kyushu University

Organized by **Kyushu University G-COE program "Novel Carbon Resource Sciences"**

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Research Institute for Applied Mechanics, Kyushu University

P R O G R A M

December 3rd (Thursday)

13:00 - 13:10 Opening Address

13:10 - 14:00 **Progress of Marine Technology in China**

Lian LIAN (Shanghai Jiao Tong University, China)

Recently, along with the increasing demands on marine resources exploiting and exploration, marine technology has been showing its great importance in the national development strategy. In China, the startup of the Marine Technology Projects of The National High-Tech Research and Development Program of China (863 Program) had become an important milestone of developing marine technologies. In this paper, the 863 Program and its main achievements in marine technology as well as the main projects launched recently are introduced.

14:00 - 14:50 **The State of Unmanned Underwater Vehicles Development in Korea and Navigation, Docking and Control of UUVs**

Seok-Won Hong (MOERI-KORDI, Korea)

MOERI (Maritime and Ocean Engineering Research Institute), the engineering branch of KORDI (Korea Ocean Research & Development Institute) supported by the Korean government, is the leading institute in the development of unmanned underwater vehicles(UUV) in Korea. In 1988 MOERI launched a three-year R&D project for the system design of UUV and the development of its key technologies, and produced a low-cost ROV CROV300 in 1991. In 1997 MOERI developed a test-bed AUV named VORAM for technical researches on underwater navigation and acoustic communication, and in 2003 MOERI developed Semi-AUV for dual purpose in military and commercial usage. Recently, MOERI has developed a 6,000m depth-rated ROV HEMIRE in April 2007 with support of the Ministry of Land, Transportation and Maritime Affairs (MLTM) of Korea. The objective of this project is to create a scientific research infrastructure for studying deep-sea environment and for enabling oceanographic data surveying, deep-sea sampling for geophysics and marine biology, and subsea structure maintenance. MOERI also has developed a small AUV named ISiMI100 in 2009. The mission of ISiMI100 is to work as a test-bed AUV to develop and validate various navigation and control algorithms and instruments required to enhance the AUV’s functions in intelligence. Based on the design experience and navigation-control techniques of ISiMI100, MOERI is under developing a 6,000m depth-rated AUV named ISiMI6000 of which sea-trials will be performed by April 2011.

This lecture introduces the states of the R&D projects on UUVs development in Korea including Korean academic institutes and industrial companies as well. This lecture presents the review of our research works on development of HEMIRE ROV and ISiMI100 AUV with performance evaluation by simulation and experimental test. After the design and implementation of ISiMI100, a series of test results in a test basin and sea-trials are presented with the comparisons of simulation and experimental results.

In underwater technologies, interesting topics are underwater navigation, guidance and control of UUVs. Precise navigation and control system is essential for sea-floor survey with AUVs. A docking system is required for special purpose to increase the capability of AUVs to recharge the batteries and to transmit data in real time under sea without frequent surfacing. This lecture will discuss the underwater navigation, docking and control of AUVs. Dead reckoning (DR) navigation integrated with Doppler velocity log (DVL) and directional gyro (DG) is useful for underwater vehicles when DVL and DG can get absolute velocity and attitude of underwater vehicles, respectively. Even if the gyro and DVL are highly precise, the estimated position of DR slowly drifts as time elapses because of the bias and scale errors of the Doppler and inertial sensors. Although DR gives accurate position information for short time periods, the biases of inertial sensors induce the accumulation of errors with time. This accumulation, however, leads to very large position error for long time period. In order to reduce the position error when the vehicle is operated in long time, the navigation system needs additional reference sensors, such as global positioning system (GPS; available only at surface), long baseline (LBL) and ultra-short baseline (USBL) acoustic positioning system (APS), etc. Furthermore, the additional sensors are required for DR navigation to be set the initial position of underwater vehicles. Integrated navigation systems (INS) have been successfully developed by integrating DVL, APS, or GPS with inertial sensors. INS with inertial measurement unit (IMU) and APS may give precise position data, since APS has no accumulative error that can compensate the bias errors of IMU. However, APS gives delayed position measurements to the navigation system because of the traveling time of acoustic signal and its update rate is usually low. The measurement time delay induces asynchronous in time step of the estimated position of INS and the measured position from APS. Furthermore, position error caused by the delay depends on the velocity and direction of the vehicle as well as the measuring distance between the vehicle and the transceivers of APS. The measurement error due to time delay is time varying and it cannot be compensated by regulating the error covariance matrix. The position error caused by time delay should be large in deep sea application and moving vehicles. Without compensating the delay-induced error, INS fused with DVL, DR and APS gives erroneous position estimation. APS also has position error in every measurement, which is induced by multi-path of acoustic signal, diffraction, inaccuracy of sound speed, and movement of reference station. This lecture discusses the underwater navigation and presents an integrated navigation system fusing IMU, DVL, and additional range information developed by MOERI, which is unnecessary USBL or LBL but needs only one transponder dropped on sea-floor or fixed at surface. This lecture also introduces a docking algorithm developed by MOERI for ISiMI AUV to dock into an underwater station with one camera. To make the visual servo control algorithm, we have derived an optical flow model of the camera mounted on the AUV, where the CCD camera is installed at the nose center of the AUV to monitor the docking condition. We combined the optical flow equation of the camera with the AUV’s equation of motion, and derived a state equation for the visual servoing AUV. The control inputs of the AUV are automatically generated with the AUV’s motion and the projected target position on the CCD plane. Image process to discriminate a dock which is the final target is described. A final approach algorithm based on vision-guidance is also suggested. We integrated the vision system, image process and the final approach algorithm on ISiMI. Underwater docking experiments were conducted in Ocean Engineering Basin in MOERI to verify performance and integration of this system and showed her docking. An acoustic servo control system is under developing in MOERI with small-size USBL sensors in the nose of ISiMI100 AUV.

< Unmanned Underwater Vehicles Developed by MOERI >

VORAM AUV (1997, MOERI)

AUV for Dual-Purpose Usage (2003, MOERI)

6,000m Depth-rated Deep-sea ROV HEMIRE and Depressor HENUVY (2007, MOERI)

ISIMI 100 AUV (2009, MOERI)

14:50 - 15:10 Coffee Break

15:10 - 16:00 **Offshore Drilling Operations and the Technical Challenges in the Deep Drilling**

Tomoya INOUE (JAMSTEC, Japan)

Deep drilling can develop the exploration of resources under the formation proverbially and also the breakthrough of the earth science such as the history of the earth, climate changes and the mechanism of earthquakes.

Japan Agency Marine-Earth Science and Technology (JAMSTEC) constructed the scientific deep-sea drilling vessel Chikyu, which means Earth in Japanese. The Chikyu was designed to be capable of operating at deep sea and recover core samples by drilling the formations located deep under the seabed.

This presentation will introduce the overall offshore drilling by explaining the drilling system and drilling operations of the Chikyu. Also it will cover the technical challenges in the “Chikyu” for the deep drilling.

16:00 - 16:50 **Japan’s R&D Visions for Deep-sea Resources Developments**

Tetsuo YAMAZAKI (Osaka Prefecture University, Japan)

Japan has three large deep-sea potential resources in the EEZ. They are the Kuroko-type seafloor massive sulfide deposits (SMS) in the Okinawa Trough and the Izu-Ogasawara Oceanic Island Arc, cobalt-rich manganese crusts (CRC) around the Okinotori-shima and the Marcus Islands, and methane hydrates in the Nankai Trough. The developments are very important not only for stable supply of metals and energy for the domestic demands but also keeping the innovative industries in higher levels. Japan should be the leading and pioneer country for developments of the resources. These three deep-sea resources are introduced. Japan’s long-term R&D visions necessary for the developments are discussed.

16:50 - 17:00 Closing Address

contact

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