

Special Feature Articles on Autonomous Operation

(Foreword: Invited Paper)

Current Status and Future Outlook of Automated Driving

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Various studies on automated driving are underway in the automotive field, and it is thought that many aspects of these moves are also applicable to automated operation of ships. Therefore, this paper describes the current status and future outlook of automated driving of automobiles in the hope that this may serve as a useful reference when studying automated operation of ships.

Risk Assessment of Autonomous Ship Systems

..... *National Maritime Research Institute, National Institute of Maritime, Port and Aviation Technology*

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With increasing activity in technology development related to autonomous ships, there are many cases in which risk assessments of systems for automatic navigation are necessary before introduction. Risk assessment of those systems is difficult, as they utilize software-centered technologies which are difficult to assess by the conventional risk assessment technologies for hardware equipment, etc. and assume diverse methods of use. However, assessments are gradually becoming possible by the introduction of leading-edge analysis techniques and extension of conventional techniques. This paper introduces those types of risk assessment methods for automatic navigation systems, including examples of efforts by the National Maritime Research Institute (NMRI).

Development of Comprehensive Simulation System for Autonomous Ships

..... *National Maritime Research Institute, National Institute of Maritime, Port and Aviation Technology*

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In recent years, efforts toward the realization of Maritime Autonomous Surface Ships (MASS) have been promoted in many countries, including Japan. In autonomous ships and unmanned ships, prevention of accidents due to human factors and improvement of safety are demanded, but on the other hand, social acceptance is also necessary for commissioning of those ship operations. Thus, it is necessary to show that autonomous ships are safe. The National Maritime Research Institute (NMRI) is studying methods for evaluating safety and the construction of the system necessary in such evaluations. Among those efforts, this paper reports on a study of a total simulation system consisting of multiple simulation systems, beginning with a ship handling simulator, and an evaluation method using simulations.

Automation Levels of Automated/Autonomous Ships

..... *Japan Ship Technology Research Association Junji FUKUTO*..... 35

The image of ships and ship operation evoked by the terms automated ship and autonomous ship is not necessarily fixed and differs depending on the individual. In reality, the modes of ship operation using automated systems include a diverse spectrum from manual operation to fully automated operation, and it is important that those concerned have a shared recognition of the image of the automation system which is the target of development or evaluation. Therefore, this paper surveys the content of past studies of automation levels aimed at achieving a common understanding of the relationship between humans and the functions of various types of automation systems, and summarizes the outline and factors used in classifying automation levels for the automation levels of automobiles and drones, as automation is progressing in those fields, together with the automation levels proposed by various types of maritime-related organizations and several ship classification societies up to the present.

Technical Topics

Initiatives for Ship Fire Safety Measures

..... *Machinery Rules Development Department, Material and Equipment Department*..... 51

This paper presents a commentary on trends in fire safety measures currently under discussion in the IMO for container carriers and car carriers. The efforts of ClassNK responding to moves to implement additional fire safety measures being promoted voluntarily by ship owners and ship management companies that operate container carriers in advance of future revisions of the SOLAS Convention, and fire safety measures for car carriers proposed in a Japanese working group are introduced.

Estimation of Stress on Ship Structures Using Full-Scale Measurement Data and Machine Learning

..... *Research Institute*..... 59

From the viewpoint of ensuring the safety of ships, it is important to understand the history of stresses generated on the ship structures. Since stress measurement is costly, it is desirable to have a method to grasp the stress of the whole ship with fewer measurement points or establish a method for stress estimation. For understanding the history of the stress, an approach using machine learning, which has been developed in recent years, is considered to be effective. In this paper, the contents of the ongoing research on estimation of stress generated on ship structures using full-scale measurement data and machine learning will be introduced.

Consideration of Utilization of Autonomous Drone for Ship Surveys/Inspections

..... *Research Institute*..... 67

In recent years, the application of robotics technologies, such as drones, has become increasingly active in various fields, and expectations are rising for the effective utilization of these latest technologies in surveys by classification surveyors and in inspections by crew. The Society has been extracting technical requirements for drones that can fly autonomously and stably in non-GNSS and dark environments such as cargo holds and has been studying survey/inspection schemes suitable for ship survey when using autonomous drones. This paper describes the results of demonstration experiments using an autonomous drone equipped with vision sensor.

This article introduces recent topics discussed at IMO (International Maritime Organization). At this issue, a summary of the decisions taken at 76th Marine Environment Protection Committee (MEPC 76) is provided.

