

History, State-of-the-arts and Future Trend of Ship Manoeuvrability and Controllability

- Thirty Years Research Review -

Kazuhiko Hasegawa
Osaka University
Japan

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Background and History of the Research

- Ship manoeuvring research in 1970s
- Autopilot for saving energy
- Necessity of the research of man-machine System
 - Developing a ship handling simulator, as one of the oldest ones in the world
- Developing standard mathematical model of ship manoeuvring

Ship Manoeuvring Model in 1980s

- **Necessity to develop a model for new types of ships**
 - MMG model (module type mathematical model considering hull, propeller, rudder and their interactions respectively)
- Still now several variation of MMG model exists
- Some extended MMG models applicable for twin-propeller ship, for shallow water etc. exist

Ship Manoeuvring Model in 1970s

- **David and Schiff Model**
- **Abkowitz Model**
- **Nomoto's K-T Model**
 - **First order Model**
 - Second order model
 - Second order non-linear model
- Necessity to develop a model for new types of ships

VLCCs



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First Generation Ship Handling Simulator (1974)

- Feasibility study on instability criterion of human ability to control a VLCC (SR151, Japan)
 - Nomoto, K., Simulators from the naval architects point of view, Proceedings of MARSIM, Southampton, UK, 1978
 - T. Koyama, K. Kose and K. Hasegawa : A Study on the Instability Criterion of the Manual Steering of Ships (in Japanese), J. of the Society of Naval Architects of Japan (J.SNAJ) 142, pp.119-126, Dec., 1977

First Ship Handling Simulator in the world (Hiroshima University, 1970)

The diagram illustrates the components of the simulator. A person is seated at a control station with a helm indicator, compass display, and steering wheel. A visual display projector shows a screen with a bridge-view. The system is connected to an analogue computer, which is linked to a ship model and a noise generator. A power supply and data recorder are also shown.

SR151 Ship Handling Simulator (1974)

This diagram provides a detailed view of the simulator's internal components. It shows the control room with a steering wheel, helm indicator, and compass. The system is connected to a computer (labeled 'アナログコンピュータ') and a ship model. The diagram includes various electrical connections and components like a 'データレコーダ' (data recorder) and '電源装置' (power supply).

Full Mission Ship Handling Simulator

The photograph shows a modern, realistic ship handling simulator. It features a large, curved bridge structure with multiple levels, a panoramic view of the sea, and various control stations and displays. The environment is dimly lit, with the primary light coming from the bridge's interior and the view through the windows.

Background and History of the Research (contin'd)

- Developing intelligent ship control systems including
 - collision avoidance
 - berthing/deberthing control
- Developing a tool for safety assessment in congested waterways
- Developing standardisation of mathematical model of ship manoeuvring in low speed and/or in shallow water etc

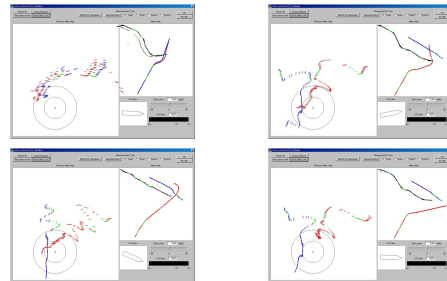
Automatic Collision Avoidance

- Fuzzy Reasoning and Control
 - A. Kouzuki and K. Hasegawa : Automatic Collision Avoidance System for Ships Using fuzzy Control (in Japanese), J.KSNAJ 205, pp.1-10, June 1987
 - K. Hasegawa : Fuzzy Modelling of the Behaviours and Decision-Making of Ship Navigators, Proc. of 3rd International Fuzzy Systems Association (IFSA) Congress, pp.663-666, Seattle, Aug. 1989
- Expert System for Multiple Ship Encounter
 - K. Hasegawa, A. Kouzuki, T. Muramatsu, H. Komine and Y. Watabe : Ship Auto-navigation Fuzzy Expert System (SAFES) (in Japanese), J.SNAJ 166, pp.445-452, Dec. 1989

Automatic Collision Avoidance Experiment



Automatic Collision Avoidance Experiment



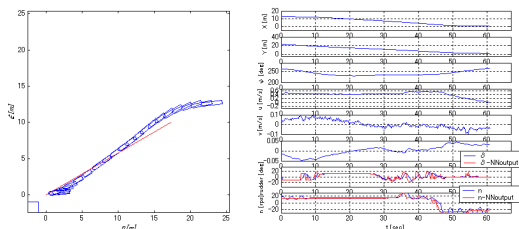
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Automatic Berthing Experiment

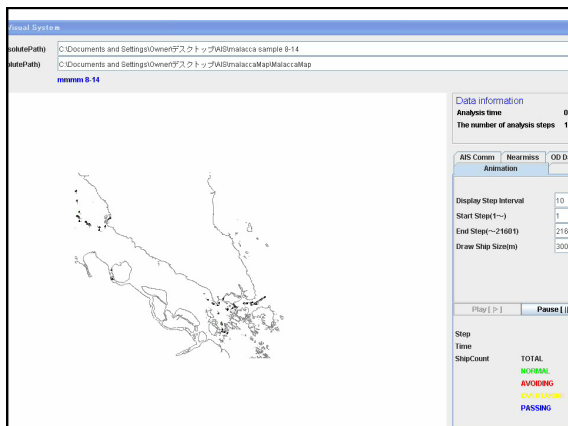


Automatic Berthing Experiment



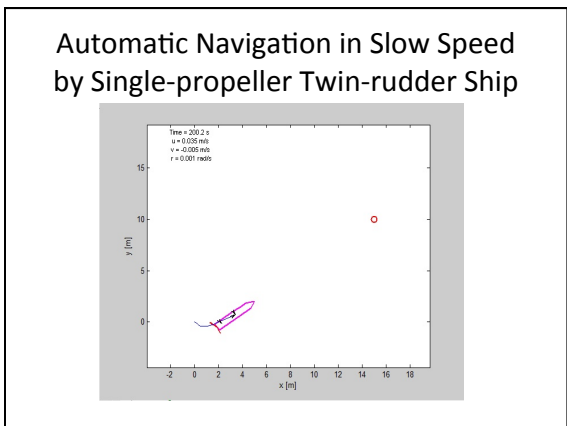
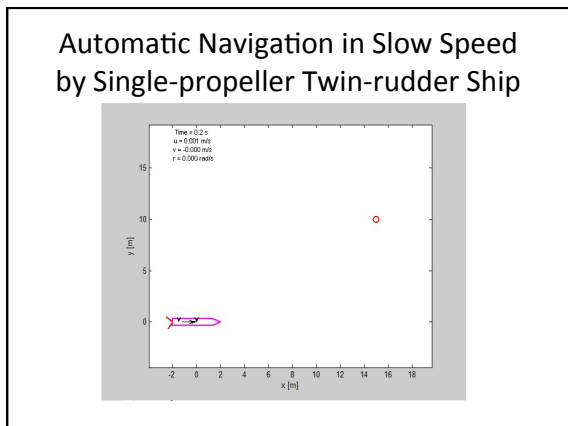
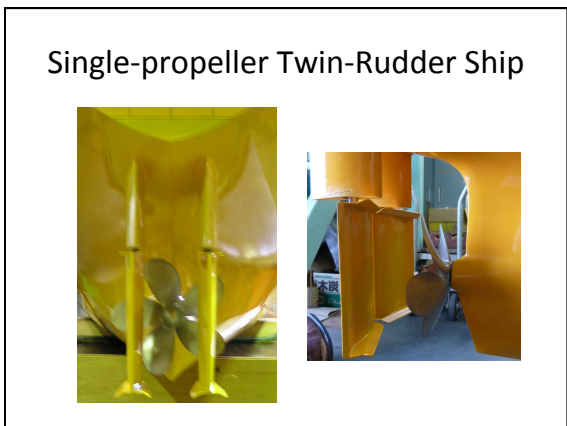
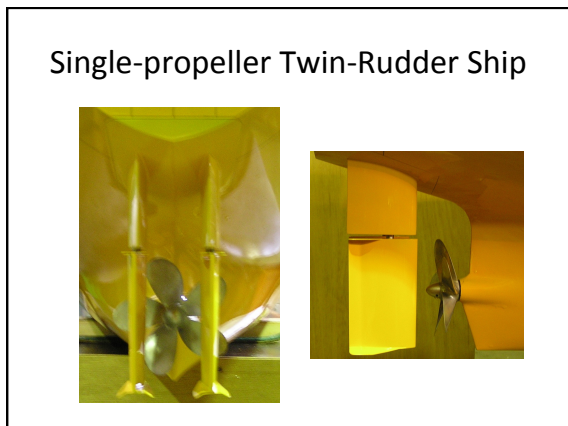
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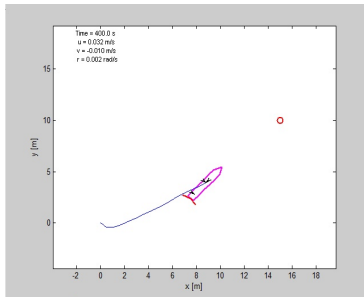


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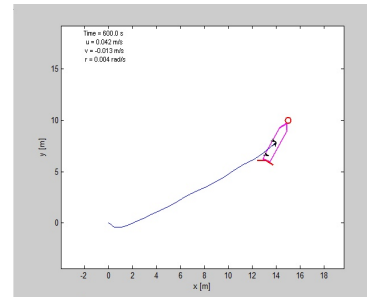
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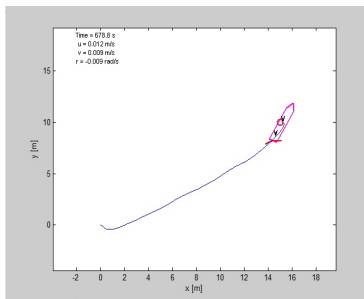
Automatic Navigation in Slow Speed by Single-propeller Twin-rudder Ship



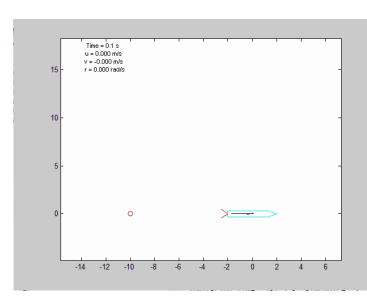
Automatic Navigation in Slow Speed by Single-propeller Twin-rudder Ship



Automatic Navigation in Slow Speed by Single-propeller Twin-rudder Ship



Automatic Navigation in Slow Speed by Single-propeller Twin-rudder Ship



Concluding Remarks

- Ship manoeuvrability and its prediction are long-time subject.
- It cannot be separated with human and autopilot behaviours and with environmental disturbances.
- New devises, new theories and new ideas to overcome these important issues are highly recommended to be searched by younger generation.