Ship Manoeuvrability and Its Control
- Thirty Years Research Review -

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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

VLCCs

Ship Manoeuvring Model before 1970

• 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

Model Ship Experiments
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

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

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Adaptive Autopilot

- Model Reference Adaptive Control
- Self-tuning Control
- Stochastic Model
- Adaptive Control
  - etc

Cost Function of Fuel Consumption

- Koyama’s criterion J = ψ² + λδ²
- Norrin, S.H., On the added resistance due to steering on a straight course, 12th ITC,Berlin, Hamburg, 1972
- Clarke, D., Development of a cost function for autopilot optimisation, Proceedings Symposium on Ship Steering Automatic Control, Genova, Italy, 1980
- Hasegawa’s criterion
  - etc

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- etc
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

SR151 Ship Handling Simulator (1974)

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

Background and History of the Research (cont’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

Full Mission Ship Handling Simulator

Automatic Collision Avoidance

• Fuzzy Reasoning and Control
• Expert System for Multiple Ship Encounter
Automatic Collision Avoidance Experiment

Background and History of the Research (contin’d)

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Automatic Berthing Experiment

Background and History of the Research (contin’d)

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Background and History of the Research (contin’d)

- Developing intelligent ship control systems including
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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.