SHIP MANOEUVRABILITY, CONTROL AND NAVIGATIONAL SAFETY

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Condolence on Haruo Eda (1926-2010)

Condolence on Takao Inui (1920-2012)

Who are we?

- To answer to this question is not only the one of the tasks but the task of science.


Sea

- (Hindi) Samudra
- (Chinese and Japanese) 海 and 母
- (French) Mère and Mer
Technology

- (Hindi) ?
- (Greek) Ἐκχειρία
- (Chinese and Japanese) 天

Philosophy vs. Science

- (Greek) "Philo" (love) + "sophia" (wisdom) = Love and pursuit of wisdom by intellectual and moral self-discipline
- (Latin) "Scientia" (know) <-- scire (cut)
- Akira Takamatsu (11 year-old boy): It starts always from one "why"?

"Know" vs. "Understand"

- "I know it" vs. "I understand it"
- We need philosophy to understand science and technology
- (tips) B.Sc. vs. B.Tech.

Manoeuvrability

- "Manoeuvre" + "ability"
- <-- "mano" = hand

Control

- (Latin) Contra rotulus = "Contra" + "roll" = rotate reverse

Conclusions

- We love science and technology
- We want to know it and understand it
- For this purpose we need philosophy
- We proud of our research and education field related to the sea, mother of all lives. We still keep our memory of the time we were in the sea, when we are in the sea (ammon liquid) of the belly (matrix) of our mothers.
- You (sea) are in our mother (in French) and our mother is in you (in Chinese and Japanese).
Ship Manoeuvring Model before 1970

- David and Schiff Model
  - Davidson, H.S.M., and L.S. Schiff, Turning and course keeping qualities, Trans. SNAME, Vol. 54, 1946
- 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 1970s

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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

Adaptive Autopilot

- Model Reference Adaptive Control
- Self-tuning Control
- Adaptive Autopilot for Steering of Large Ships
- Stochastic Model
- etc.

Cost Function of Fuel Consumption

- Decision on a question of whether to choose a vessel of slow speed or fast speed
- etc.

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First Generation Ship Handling Simulator (1974)

- Feasibility study on instability criterion of human ability to control a VLCC (SR151, Japan)
  - etc.

Dec. 7, 1972

40th Anniversary of Apollo 17 launching
First Ship Handling Simulator in the world (Hiroshima University, 1970)

SR151 Ship Handling Simulator (1974)

Intelligent Ship Handling Simulator (2010)
- World first intelligent ship handling simulator was installed on a ship handling simulator at NMRI (National Maritime Research Institute), Tokyo as a cooperative work with Osaka University and NMRI.
- To be presented at the spring meeting of JIN (Japanese Institute of Navigation) at Kobe, May 2011.

Intelligent Ship Handling Simulator

Reproduction of an accident

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
- Expert System for Multiple Ship Encounter

Automatic Collision Avoidance Experiment

Automatic Berthing Experiment

Background and History of the Research (contin’d)

- Developing intelligent ship control systems including:
  - collision avoidance
  - berthing/docking 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
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

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.
Capsizing Experiment
(by Prof. Umeda and Hashimoto)

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(by Prof. Umeda and Hashimoto)

Arbitrary Wave Generator
(by Profs. Naito and Minoura, Osaka University)

Squid Robot
(by Prof. Toda, Osaka University)

Squid Robot
(by Prof. Toda, Osaka University)

Thank you for your attention and
You are always welcome to come to Japan

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