A Navigational Information Display System for Supporting Decision Making for Collision Avoidance

- Utilizing Obstacle Zone by Target (OZT) -

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• Introduction of NMRI
• Background
• A Collision index: Obstacle Zone by Target (OZT)
• Navigational Information Display System
• Experiments
• Summary
Introduction of NMRI
Introduction of NMRI

Mission of NMRI

Outline

- NMRI provides solutions for policy issues on safe maritime transport and protection of marine environment, Ocean development, utilizing large-scale experimental facilities and high potential on technology.
- NMRI also contributes to strengthening competitiveness of maritime industry through research and development activities.

<table>
<thead>
<tr>
<th>Ensuring safe maritime transport</th>
<th>Protection of marine environment</th>
<th>Ocean development</th>
<th>Competitiveness of maritime industry</th>
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<tbody>
<tr>
<td>Clarification of cause of marine accident and prevention of recurrence</td>
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<td>Integrated analysis for ship structure</td>
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<td>Simulation for marine traffic</td>
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<td>Reduction of emission of NOx, SOx, CO2 etc. from ships’ engine</td>
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<td>Prediction of noise underwater</td>
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<td>Ships’ machinery system utilizing various energy sources</td>
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<td>Basic technology for ocean renewable energy such as tidal wave</td>
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<td>R&amp;D for subsea system for Sea-floor hydrothermal deposit</td>
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<td>Technology for underwater exploration</td>
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<td>Operation support system utilizing Information Communication Technology</td>
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<td>Improvement of productivity utilizing robot technology</td>
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<td>Regional maritime transportation system to adapt to aging society</td>
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</table>

Future effort

- NMRI will concentrate its effort to R&D activities that contribute to sustainable development and strengthening competitiveness of national maritime industry.
- NMRI will be the coordination basement of industrial/academic/governmental sectors on maritime transport utilizing technical know-how, research facilities and human resources.
Background
Background

- Many collision accidents are caused by human error
- Conventional navigation systems such as radar and AIS are insufficient

Q: Do you think the current equipment is sufficient for safe navigation?

- Yes 33%
- No 67%

67% of crews consider the current navigation equipment insufficient

Japan Ship Machinery and Equipment Association, Research and Development of Ship Monitoring System through Information Integration, 2005 (in Japanese)
To develop the navigational support system, we have started a joint research project with Mitsui O.S.K. Lines, Ltd., MOL Techno-Trade, Ltd., and Tokyo University of Marine Science and Technology.
A Collision index: Obstacle Zone by Target
Obstacle Zone by Target (OZT)

- The collision area is calculated by the relative position and motion of a target ship.
Comparison of OZT and DCPA

- Distance of Closest Point of Approach (DCPA)
  - Difficult to find a safety pass in a congested water
- Obstacle Zone by Target (OZT)
  - The risk areas are drawn on the map
  - Easy to find a safety pass in a congested water
Comparison of OZT and DCPA

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Which way is safe?
Comparison of OZT and DCPA

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Which way is safe?
Navigational Information Display System
Tablet-type Display System

- Landscape Image
- Route
- Radar Image
- Own Ship
- OZT

Tablet PC
Demo

(20x faster)
Experiment
Experiment

- Experiments with Bridge Simulator in NMRI
- 4 scenarios
- 8 Subjects (4 Novices, 4 Experts)

Subjective Evaluation
- The NASA Task Load Index

Objective Evaluation
- Trajectory

Camera
Display System
Scenarios

1st Stage:
- Avoid several target ships

2nd Stage:
- Cross the east-and-west traffic flow
## Subject Profiles

<table>
<thead>
<tr>
<th>No</th>
<th>Certificate of Competency</th>
<th>Total time on ship</th>
<th>Type of Vessels with Experience on Board</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3rd grade</td>
<td>One year</td>
<td>Training Ship</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Two months</td>
<td>Training Ship</td>
</tr>
<tr>
<td>3</td>
<td>3rd grade</td>
<td>One Year</td>
<td>Training Ship</td>
</tr>
<tr>
<td>4</td>
<td>3rd grade</td>
<td>One Year</td>
<td>Training Ship</td>
</tr>
<tr>
<td>5</td>
<td>2nd grade</td>
<td>Six years</td>
<td>PCC, LNG</td>
</tr>
<tr>
<td>6</td>
<td>2nd grade</td>
<td>Three years.</td>
<td>LNG, VLCC</td>
</tr>
<tr>
<td>7</td>
<td>1st grade</td>
<td>Ten years</td>
<td>Bulker, LNG, VLCC, Container</td>
</tr>
<tr>
<td>8</td>
<td>2nd grade</td>
<td>Ten years</td>
<td>Bulker, LNG, VLCC</td>
</tr>
<tr>
<td>Subject1</td>
<td>Subject2</td>
<td>Subject3</td>
<td>Subject4</td>
</tr>
<tr>
<td>----------</td>
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<tr>
<td>Novice</td>
<td>Novice</td>
<td>Novice</td>
<td>Novice</td>
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<tr>
<td>Without OZT</td>
<td>Scenario1</td>
<td>Scenario1</td>
<td>Scenario2</td>
</tr>
<tr>
<td>With OZT</td>
<td>Scenario2</td>
<td>Scenario2</td>
<td>Scenario1</td>
</tr>
<tr>
<td>Without OZT</td>
<td>Scenario3</td>
<td>Scenario3</td>
<td>Scenario4</td>
</tr>
<tr>
<td>With OZT</td>
<td>Scenario4</td>
<td>Scenario4</td>
<td>Scenario3</td>
</tr>
</tbody>
</table>
The NASA Task Load Index

• The NASA Task Load Index (NASA-TLX) is a tool for measuring and conducting a subjective mental workload assessment

• The score is obtained by answering a questionnaire after the experiment

https://humansystems.arc.nasa.gov/groups/tlx/downloads/TLXScale.pdf
The task load of the novices is greatly reduced. For the expert, the task load is a little bit increased because they had to check the new system in addition to the equipment they usually use.
Comparison of Trajectories

- Novices follow similar trajectories as experts when using the new support system
- Experts made fewer turns and made faster decisions
Expert Experiment result Without OZT (Movie)
Expert Experiment result With OZT(Movie)
Summary

• We developed navigational information display system utilizing Obstacle Zone by Target(OZT)

• Simulator Experiment
  • The system is especially effective for novices
  • Even for experts, the number of turns was reduced and decision-making became faster

• We are planning to start testing on actual ships and evaluated for practical use and to improve OZT representation for easy course setting
Thank you.

The research is a joint research project with Mitsui O.S.K. Lines, Ltd., MOL Techno-Trade, Ltd., and Tokyo University of Marine Science and Technology.