BEYOND NAVIGATION

Insights Gained from the Commercialization of ANS (HiNAS)

May 14th 2024

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Sailing together: Striving for a future-proof IMO MASS Code

1. Current Landscape and Future Outlook of the MASS Industry

2. Overview of the Applied Autonomous Navigation System
   1) Assurance of Situational Awareness
   2) Assurance of Collision Detection & Collision Avoidance
   3) Assurance of Cyber Security

3. Impacts and Insights Gained from the Commercialization
   1) Safe
   2) Environmental
   3) Sustainable
MASS industry will grow rapidly, reaching nearly 10% of all ships by 2035

If technological maturity is secured, and relevant social infrastructure is in place, the introduction of autonomous ships is expected to accelerate.

In particular, partial autonomy is likely to dominate over remote control or uncrewed MASS.

Current business area of Avikus

- NOW: Ship with automated processes and decision support
  - In compliance with current regulations
  - Relatively easier to advance toward commercialization

- FUTURE: Fully autonomous ship
  - Uncertain & technically challenging
  - Prospect for the very distant future

- Remote controlled ship with seafarers on board
  - Need to consider product liability
  - May vary depending on the concept of the ship
As provided in document MSC 107/INF.18, feasibility of autonomous navigation system (HiNAS) has been proven through transoceanic autonomous navigation demonstration.

A one-time test for technology validation

(MSC107/INF.18) Results of a transoceanic voyage test with autonomous navigation system (HiNAS2.0)

Results from deploying the actual product for commercial use and operational use

(MSC108/INF.18) Results of the sea trial verification and the application for the actual vessel operation of the Autonomous Navigation System in the ROK
The concept of the HiNAS is to assist the navigation and manoeuvring work of the seafarers by autonomously performing the behaviours of humans.

Since this system is designed for assistance, it is a partially autonomous system, which means all the responsibility of autonomous operation is belonging to the certified officers/captain on board.

Overview of the Applied Autonomous Navigation System

- IR (Infrared) Camera (120 deg. FOV)
- EO (Electro-Optical) Camera (180 deg. FOV)
- X-Band RADAR
- S-Band RADAR
- AIS
- Infrared Camera
- Electro-Optical Camera
- ECDIS
- Autopilot
- Bridge Manoeuvring System
Enhancing situational awareness at night or in restricted visibility using infrared cameras, complemented by blended technologies for mutual reinforcement

- Computer vision and deep learning-based target detection
- IR camera-based target detection at night or restricted visibility
- The EO camera has low visibility
- IR camera cannot distinguish colors, making object classification difficult.
- EO/IR camera with blended image
Sensor fusion technology enhances accuracy by complementing individual sensor strengths and weaknesses, providing a more complete understanding of the situation.
Pan-Tilt-Zoom cameras has been implemented to **enhance the detection performance of distant objects**, while also closely imitating traditional visual lookout patterns.

**Zooming with auto-tracking**
- Auto target tracking using a PTZ(Pan-Tilt-Zoom) camera
- Following the behavior patterns of a navigator using a binocular

**Ex 1) Implementing Auto Track Mode in a ‘Head-on’ situation**

**Ex 2) Implementing Auto Track Mode in an ‘Overtaking’ situation**
HiNAS classifies encountering situations **based on COLREG but prioritize safety first** while conducting collision avoidance manoeuvre.

- Simulating various scenarios (testing over a hundred cases) before transitioning to actual operations as below
- After sufficient V&V, certification (type approval) is obtained from various classifications
- Various tests are being conducted in the large commercial ship sector under the following commissioning procedures

<table>
<thead>
<tr>
<th>Entrance of Traffic Separation Scheme</th>
<th>Inside traffic lane</th>
<th>Crossing Allowed Zone</th>
<th>Clear of Traffic Separation Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) system health check test</td>
<td>2) basic function test</td>
<td>3) interface fail test</td>
<td>4) route planning test</td>
</tr>
<tr>
<td>5) display requirement test</td>
<td>6) operation mode change test</td>
<td>7) cyber security test</td>
<td></td>
</tr>
</tbody>
</table>
We conducted concurrent real-life testing and Hardware-in-the-Loop (HIL) testing, recognizing that it is not always possible to create desired collision avoidance scenarios in actual navigation situations.
HiNAS considers as below and we have obtained KR Cybersecurity Type Approval, designed based on the international standards IEC 62443 and 61162.

The IACS UR E26 and E27 requirements are being mandatory compliance requirements from July 2024 onwards

- IACS UR E26 – Cyber Resilience of Ships
- IACS UR E27 – Cyber Resilience of On-Board Systems and Equipment

Cyber security infrastructure includes:
- Building its own security infrastructure to protect the in-ship network and autonomous system
- Application of firewalls, intrusion prevention systems (IPS), access logs and event management systems

Cyber security policy includes:
- Establish and apply security policies such as solution access control, data protection, encryption, and authentication

Cyber security risk assessments include:
- Risk assessment identifies and manages security vulnerabilities to improve security levels
- Apply remote updates such as necessary security measures through the application of OTA functions

Security monitoring and alert system include:
- Application of traffic monitoring and anomaly detection and warning system for equipment
- Remote monitoring with functionality for remote security monitoring
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MASS, Challenges for Harmonious Technology Development
Safety First with User-Centric Value

Revealing various sources of satisfaction beyond enhanced safety and reduced workload, based on real user feedback.

Detection of Man Overboard (MOB)

Utilizing generative AI to train for specific scenarios such as MOB incidents and developing adequate detection capabilities.

Effective Use for Anti-Piracy etc.

Enabling real-time 360-degree view without blind spots in 3D mode, with intuitive visualization accessible from any location onboard.
In the commercial ship industry, AI ADAS is gaining significant recognition and is poised to become industry standard in the near future

**FUTURE IS HERE**

*Captain of the container ship*

“The new display is **simple yet effectively** present the necessary navigation information, making it very nice!

Especially, it is **intuitive to perceive the risk of collision** using the congested mode and extremely convenient with the addition of wide/full-screen mode.”

**Q** How satisfied were you with the features and services provided by HiNAS

**Extremely satisfied/Satisfied** ———— 98%

- 42.5%
- 19.7%
- 21.3%
- 8.4%
- 8.1%

**The reasons for satisfaction**

- Safety improvement
- OPEX reduction
- CII compliance
- User-friendly UI
- Certifications

**Survey conducted among crew members actively using the HiNAS, 98% evaluated the solution as a valuable tool for navigation with 94% expressing that it contributes to workload reduction**

- **OPEX reduction**
  - FOC (Fuel Oil Consumption) 10~15% reduction (1M $/year fuel cost saving per ship)

- **Environmental regulation compliance**
  - The most effective solution to respond to IMO’s CII (Carbon Intensity Index) regulation

- **User-friendly UI**
  - A UI designed to evoke empathy based on user research and feedback

- **Certifications**
  - Obtained certifications (TA, PDA) from reliable authorities such as class and flag states

- Received orders of more than **400** sets

- **Standard spec.** of HD Hyundai’s new building ships (150~200 sets/year)
Utilizing generative AI to train for specific scenarios such as MOB incidents and developing adequate detection capabilities

Training data augmentation by generative AI

Logging data

Segment

InPaint

Prompt: “Aircraft carrier on the sea”

Vision Sensing

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Enabling **real-time 360-degree view without blind spots** in 3D mode, with intuitive visualization accessible from any location onboard

- Useful when passing canal, narrow channel, berthing/unberthing
- Prevent the risk of armed robbery, stowaways, smugglers, etc.
- Actual Example from Korean Ship Owner
  → They caught an attempt of a stowaway in advance using HiNAS
- Monitoring from anywhere onboard using the portable device
Reducing GHG Emissions
During the world’s first transoceanic voyage, we demonstrated that HiNAS reduced greenhouse gas emissions by 5%.

Reducing FOC about 15%
Through the long-term actual test, we could verify that about 13% of fuel oil consumption was reduced.

Cost-Effective Green Solution
HiNAS presents effective strategies for environmental regulations and holds the potential to lead the era of eco-friendly and fuel-efficient technology.
During the world's first transoceanic voyage, we demonstrated that HiNAS reduced greenhouse gas emissions by 5%
Through the long-term actual test, we could verify that about **13% of fuel oil consumption was reduced**

- Approximately the same route
- Collecting voyage data from same vessel
  → With HiNAS / Without HiNAS (Historical data for same route)
- Analyzing Fuel Oil Consumption for each historical/test case and simulated case

Confirmed achieving a **fuel savings effect of 5-15% through HiNAS**
HiNAS presents effective strategies for environmental regulations and holds the potential to lead the era of eco-friendly and fuel-efficient technology.

**[Comparison of Fuel Saving Devices for Ships]**

<table>
<thead>
<tr>
<th>Cost-saving benefits</th>
<th>Avg. 15%</th>
<th>5~8%</th>
<th>3~8%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main function</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Automatically control steering and speed via Autopilot, BMS</td>
<td>• Emitting small air bubbles onto the hull surface</td>
<td>• Install the rotating cylindrical columns</td>
<td></td>
</tr>
<tr>
<td>• Suggesting Optimal route and voyage conditions</td>
<td>• Reducing friction resistance</td>
<td>• Utilizing the pressure difference to assist propulsion</td>
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</tbody>
</table>
Impacts and Insights Gained from the Commercialization

Beneficial for Seafarers
It’s not about reducing existing maritime jobs; rather, it’s about alleviating burdens on seafarers while enhancing safety and environmental benefits.

Sustainable for Both at Sea & Onshore
Supporting sustainability through cloud services by enabling monitoring of ships or fleets both at sea and onshore.

Need for Comprehensive Cooperation
Maximizing the ripple effect of MASS requires comprehensive cooperation across technical, regulatory, social, and economic impacts.
It's not about reducing existing maritime jobs; it's about alleviating burdens on seafarers while enhancing safety and environmental benefits.

Enhancing safety and efficiency

Autonomous ships not only enhance navigation safety but also benefit crew mental health by reducing the burdens of navigation and improving management process efficiency.

Empowering seafarers to gain industry expertise

Seafarers can prepare for the future of the shipping industry by enhancing their expertise in the operation and management of autonomous ships.

Transforming industries through technological advancements

New jobs may emerge for example, technical engineers, data analysts, and maintenance and repair specialists to operate and monitor autonomous ships.

This will improve productivity and job satisfaction by providing a safer and more efficient working environment for seafarers.

Seafarers' expertise in ship navigation remains crucial and offers them broader opportunities to advance their specialized skills.

These roles enable seafarers to adapt to new responsibilities and technologies in the evolving maritime industry.
Supporting sustainability through cloud services by enabling monitoring of ships or fleets both at sea and onshore

- Providing schedule monitoring, location tracking, OTA software update, black box function, etc.
- Real time fleet monitoring for safety, fuel consumption, and GHG emission.
Maximizing the ripple effect of MASS requires comprehensive cooperation across technical, regulatory, social, and economic impacts.

- **Technical**
  - Development of AtoN suitable for MASS
  - Cooperation with VTS
  - Data and comm. standards

- **Regulatory**
  - Consideration of potential risks
  - Regulations for uncrewed MASS
  - Practical regulatory framework

- **Social**
  - Acceptance and trust
  - Safety awareness
  - Employment impact

- **Economic**
  - Initial investment cost
  - Operational efficiency
  - Optimized DoA for each vessel
Impacts and Insights Gained from the **Commercialization of ANS (HiNAS)**

**Conclusion**

Deploying the actual product for commercial use and operational use

The necessity of assuring

- Situational Awareness
- Collision Avoidance & Collision Detection
- Cyber Security

SAFE

ENVIRONMENTAL

SUSTAINABLE

Sailing together
We should strengthen cooperation and share insight with various stakeholders.

In the era of maritime digitalization, MASS emerge as a crucial topic.

The development and commercialization of MASS require a comprehensive strategy, necessitating continuous collaboration and knowledge exchange among key stakeholders in technology, infrastructure, and regulation.

Through these efforts, we can effectively address multifaceted challenges and enhance maritime safety and environmental protection.
Your partner for safer and greener voyage

THANK YOU

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