Application of the Navigation Brain System to Smart Ships

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Outline

1. Developments of the Navigation Brain System
2. Application of the NBS to Inland Ferries
3. Application of the NBS to Virtual-real Interaction Tests
4. Application of the NBS to Remote-control Operations
5. Conclusions

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Rise of Smart Ships

Since 2012, the research on ships intelligent and unmanned at world has begun to flourish. However, there are still some differences in specific technical routes, technical methods, and application scenarios. At the present time, there is still a need for innovation in technology.

MUNIN

Maritime Unmanned Navigation through Intelligence in Networks

2012 2013 2014 2015 2016 2017 2018

Presented by Dr. Robert Hekkenberg 2017

Concept of Smart Ships

A ‘smart ship’ means the use of sensors, communications, the Internet of Things, and other technical means to automatically perceive and obtain information and data on the ship itself, the marine environment, logistics, ports and other aspects, and based on computer technology, automatic control technology and large data processing and analysis technology, the ship can be intelligently operated in terms of ship navigation, management, maintenance, cargo transportation, etc., so that the ship is safer, more environmentally friendly, more economical and more reliable."

——CCS intelligent ships standard 2015

Smart ships realize safety / efficiency / economy / environmental protection from perception to decision making during the whole lifecycle.

Current Status and Future Needs of Smart Ships

China has abundant inland shipping resources, playing an important role in the economic growth

Inland shipping resources

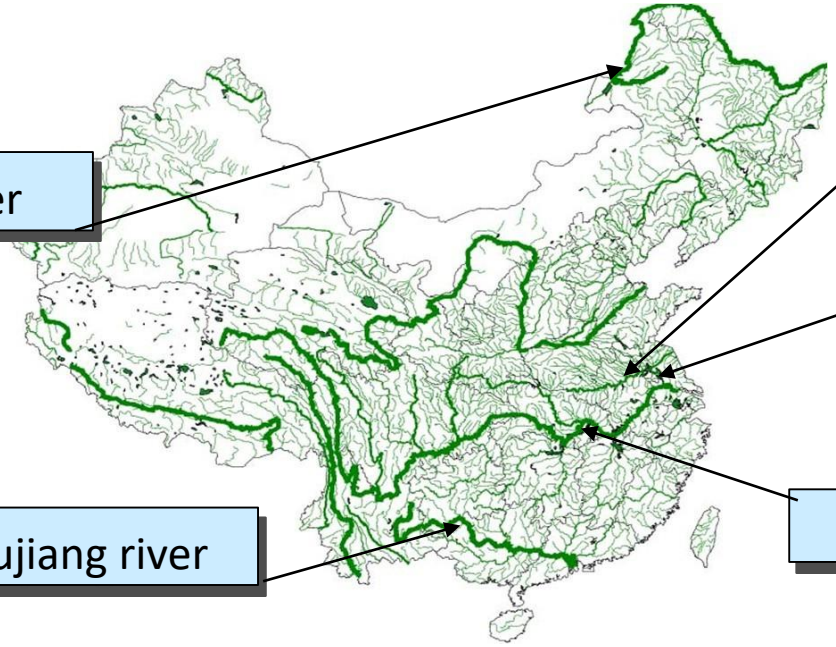
Navigational mileage of inland waterway: **127,100 km**.

Amount of inland ships: **152,500**.

Inland shipping contribution

55% of China's cargo transport volume

Cargo transport volume of inland shipping (including coastal) is **8** times that of ocean-going shipping.



Roadmap from Our Point of View

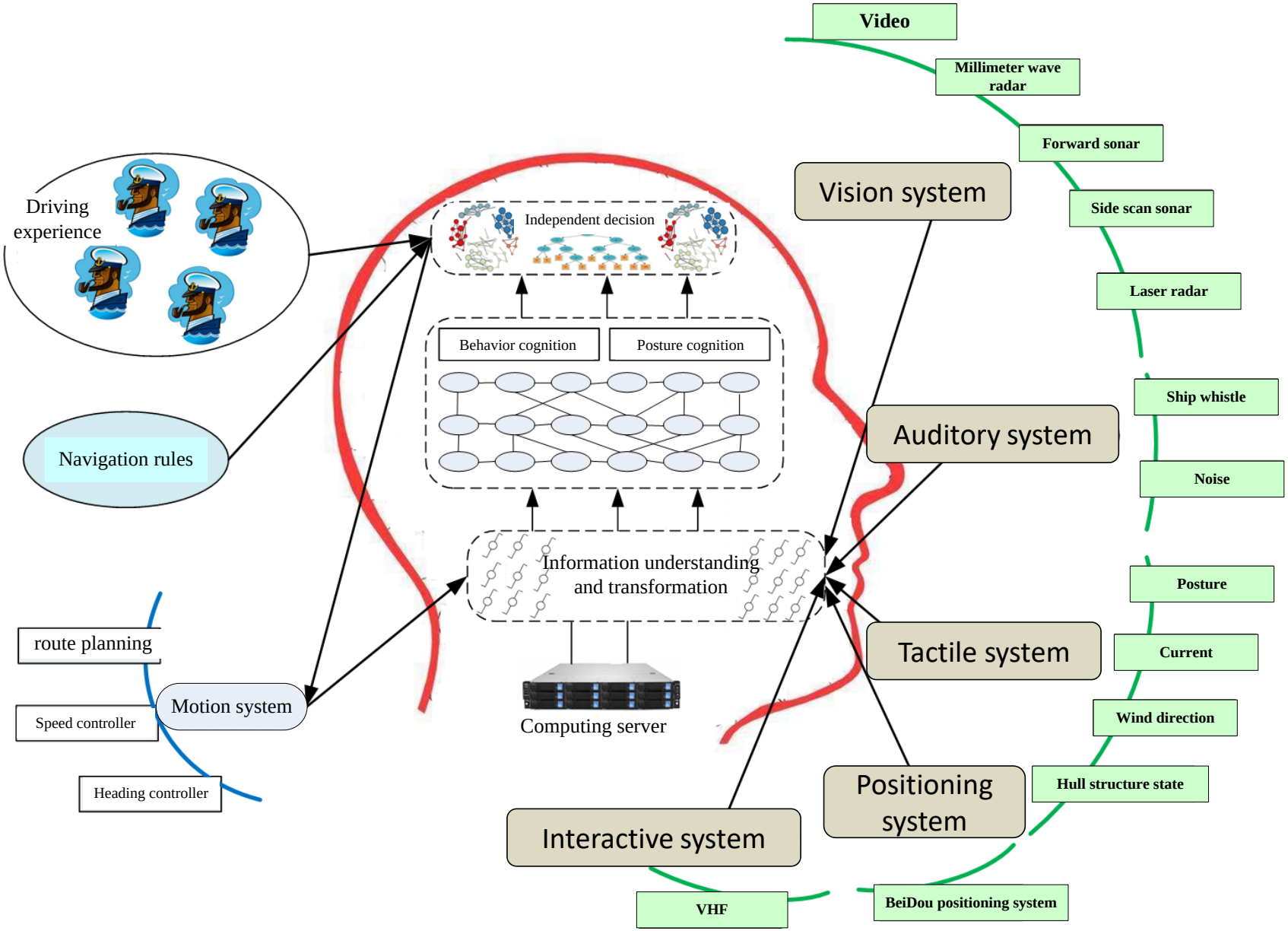
Two critical changes:

1. **When will the 'system' have the ability to make comparable decisions as human do?**
2. **When will the 'system' have the ability to take over the control of ships from the captain and carry out its decision?**

Perception Enhancement

Making Assistance

Concepts of the Navigation Brain System



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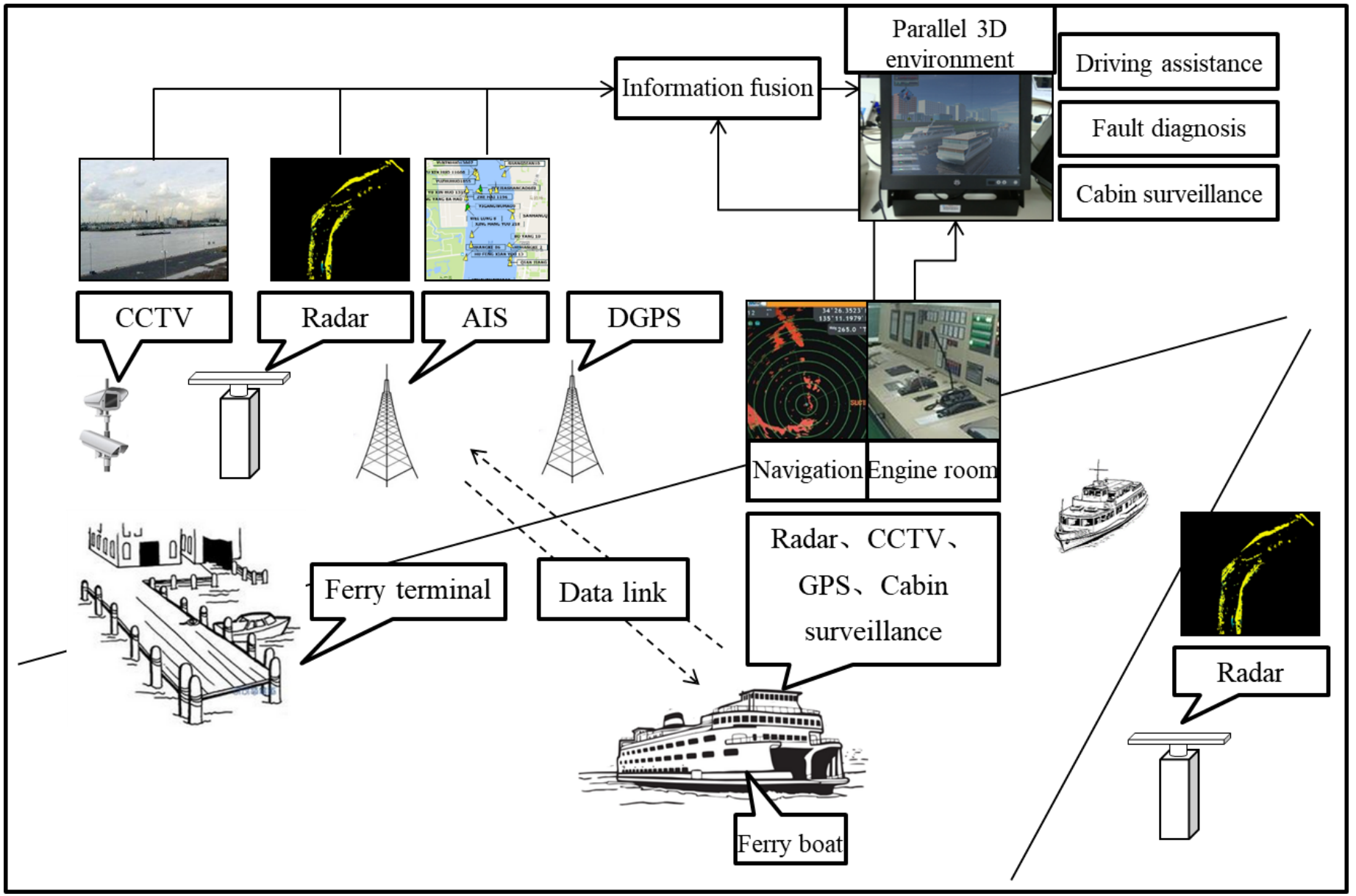
Practical Challenges of Inland Ferries

Run 24 h per day and 7 days per week

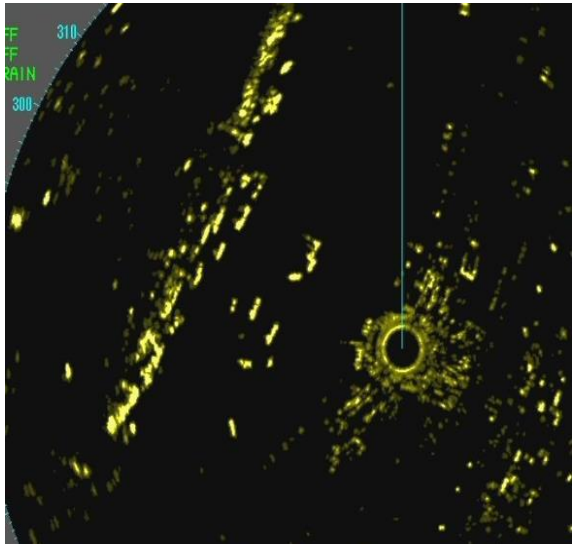
No stop in foggy or rainy days.

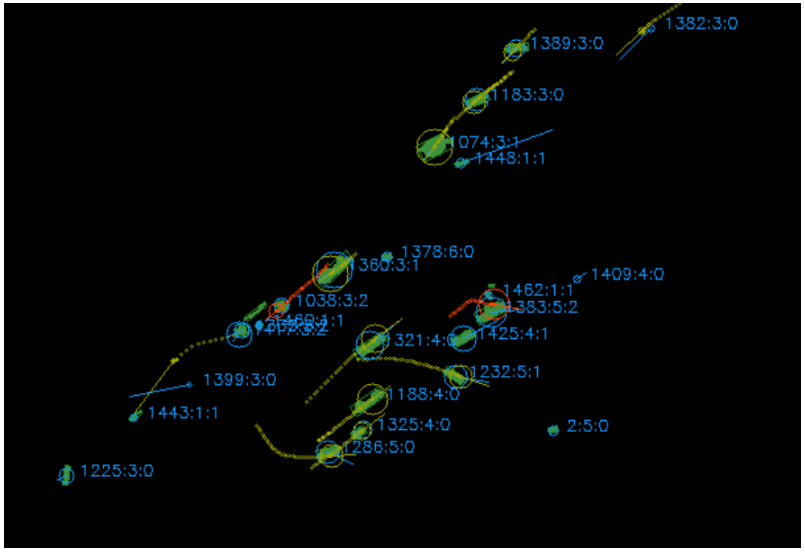
Continuously cross busy traffic
(maximum 18000 ships per day)

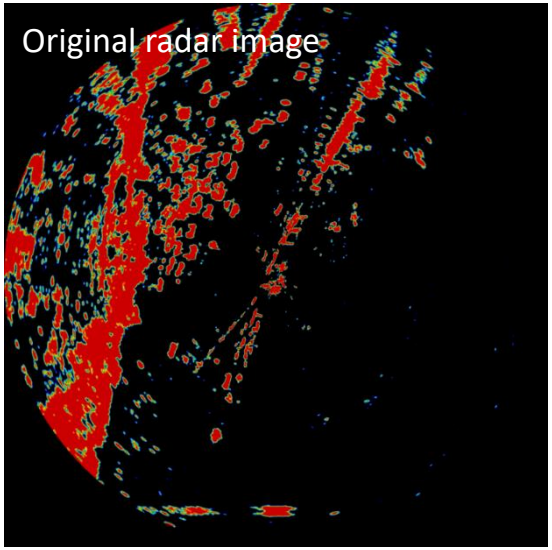
Ship-Shore Coordination



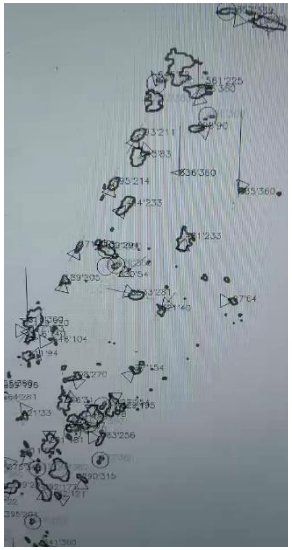
RADAR perception







Target Recognition



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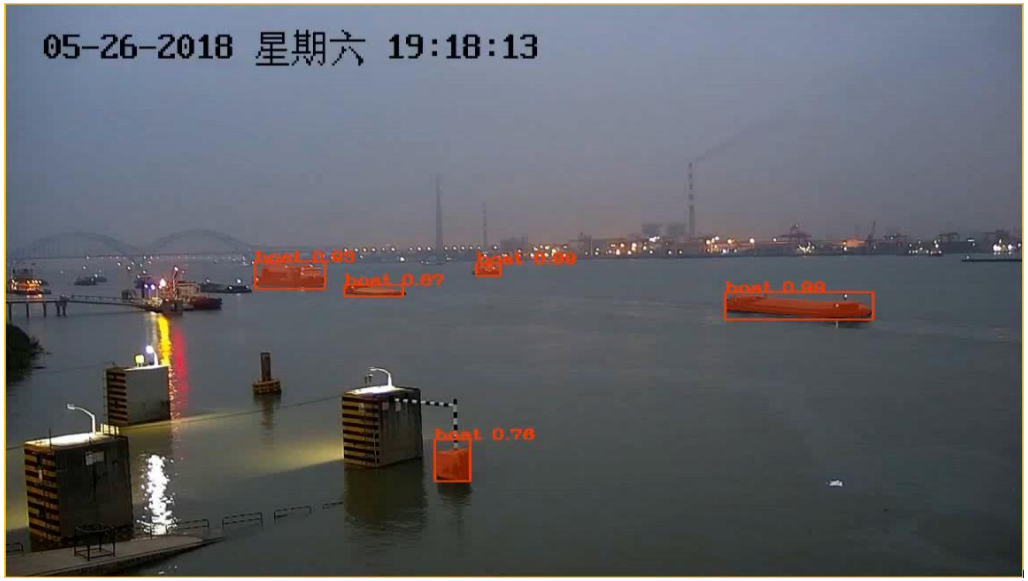
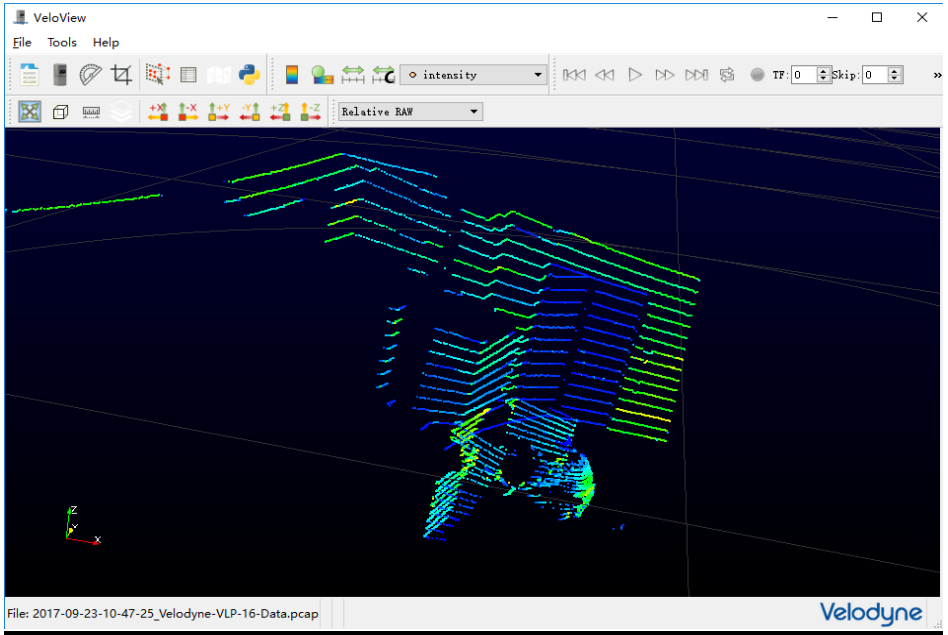
Video Perception



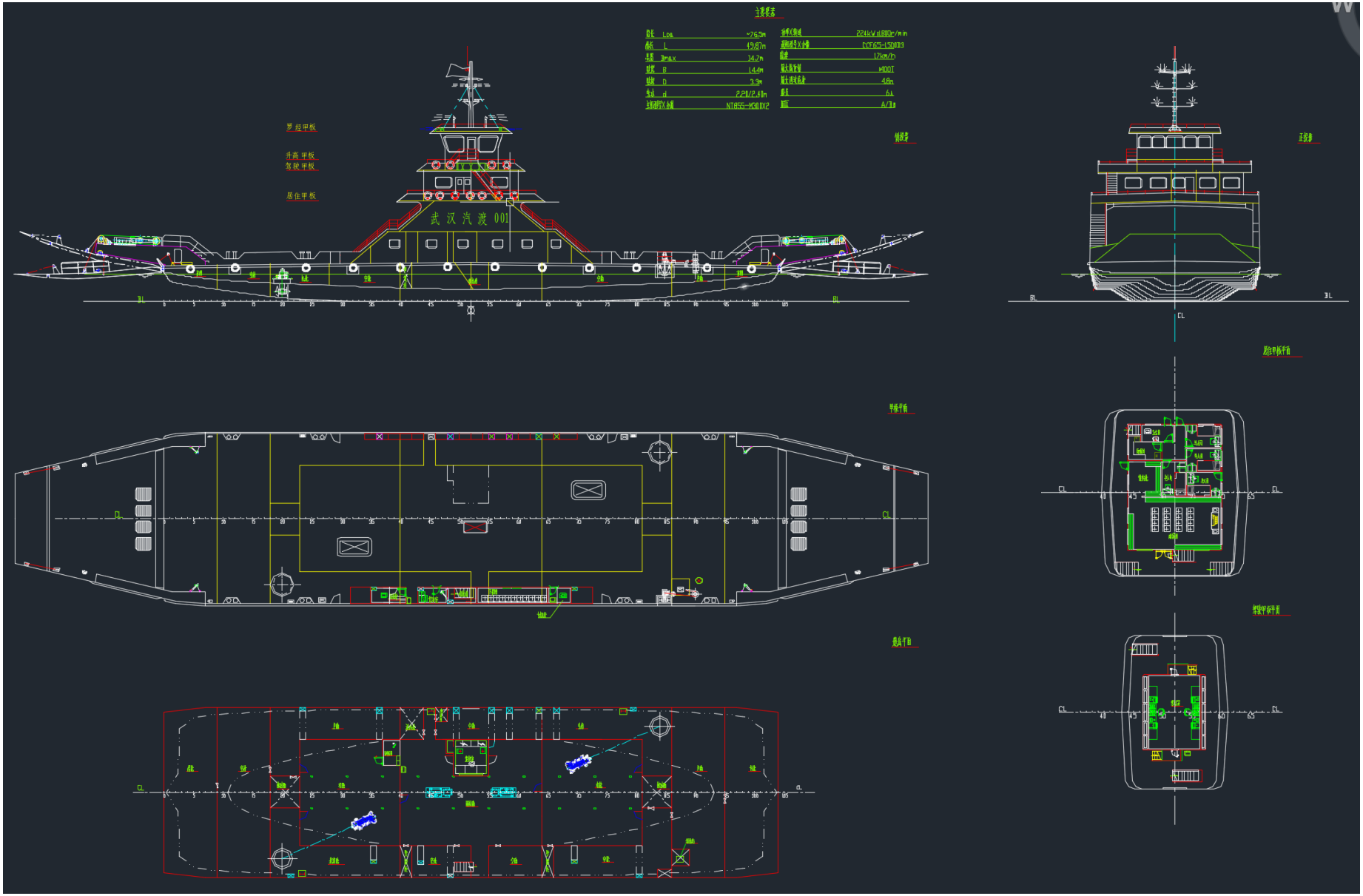
LIDAR perception

LIDAR

Data collection and processing

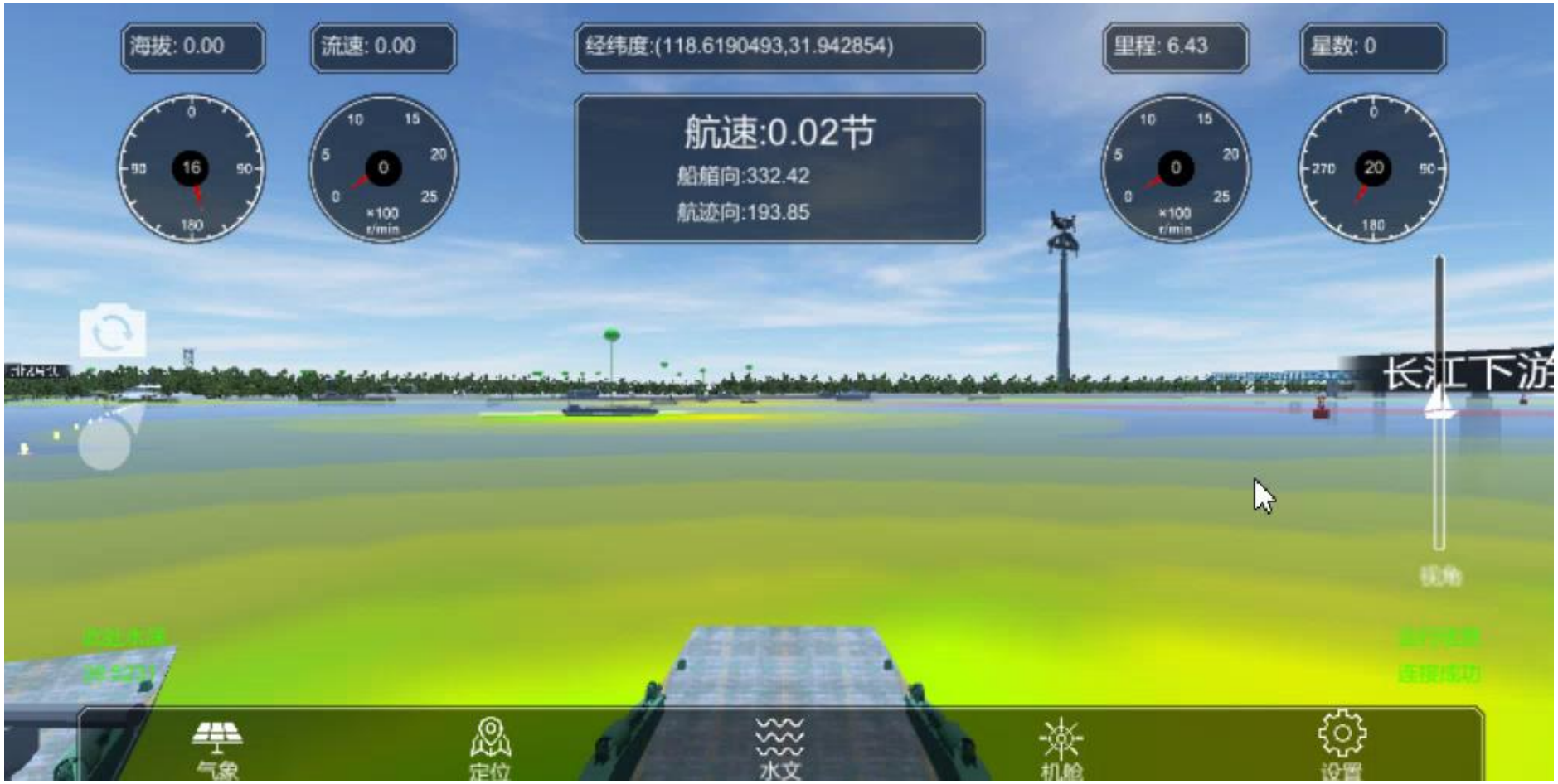


Motion Modeling and Control for Risk Perception

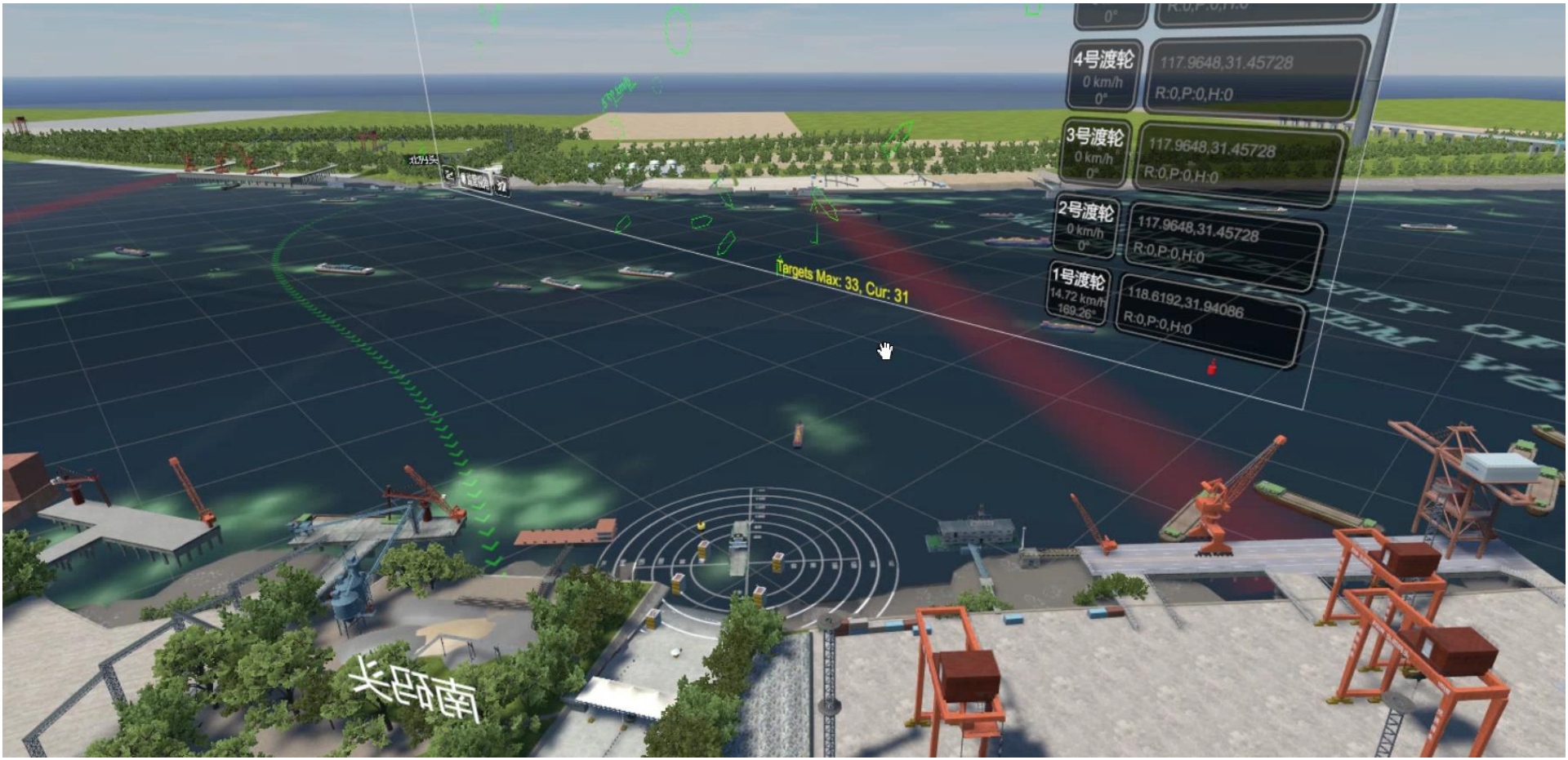


Challenges of Sailing through Night in Nanjing

Applications of the NBS to Inland Ferries



Applications of the NBS to Inland Ferries



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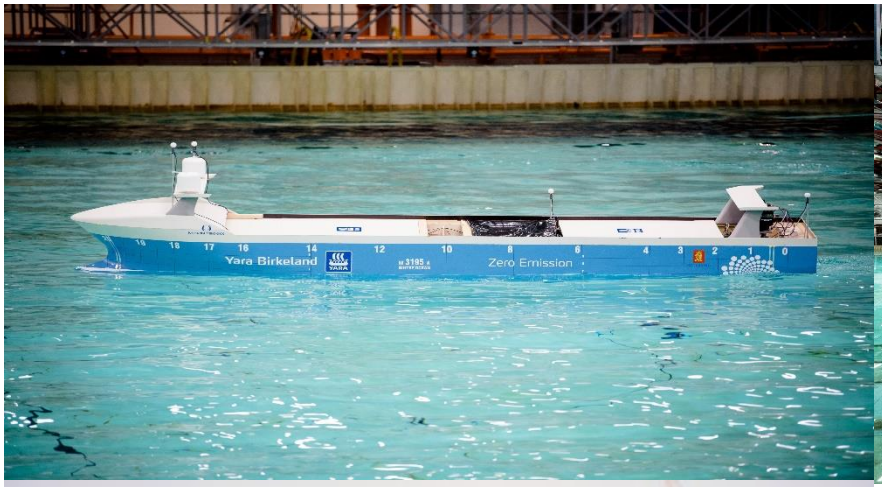
Current status of model tests



5 m model test for Yara Birkland

25 m model of Harbin Engineering University

Current status of ‘human’ tests

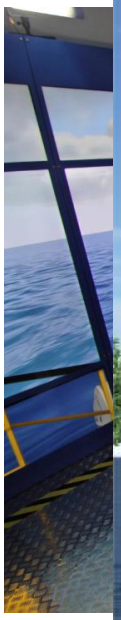
K-Sim® Polaris - Ships bridge simulator

Expensive and closed

No room for DIY

No real-time info of the environment

The Idea of Virtual-real Interaction Tests for Smart Ships



Test a virtual ship that is controlled by AI in ‘real world’

Trad

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Sour

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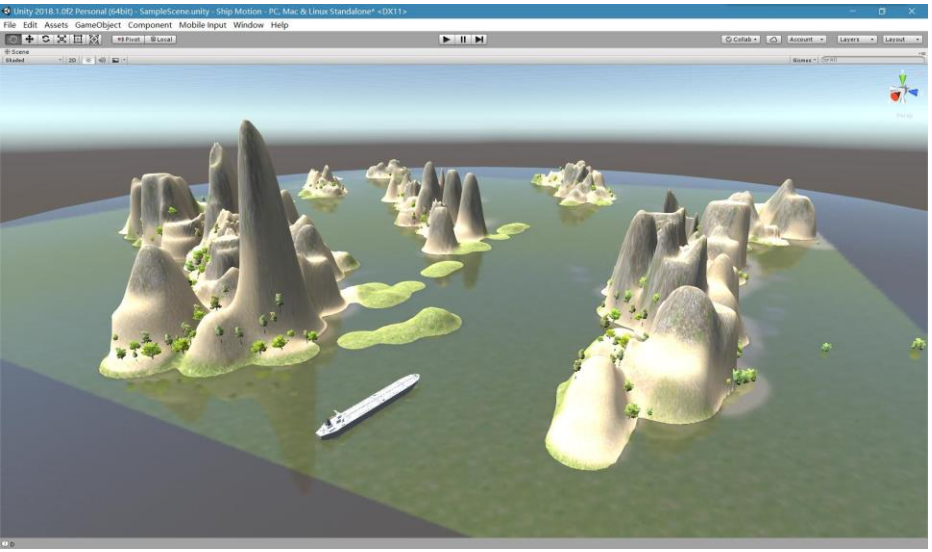
Creation of a Virtual World

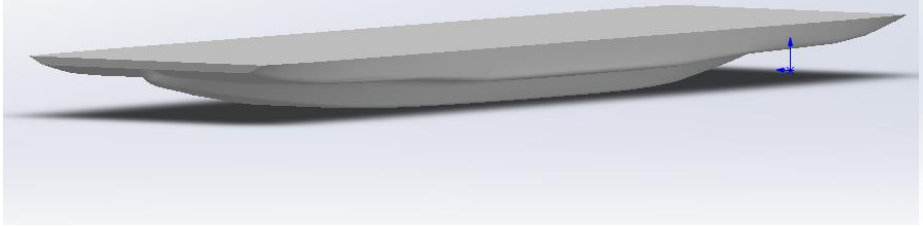


Virtual test bed for smart ships

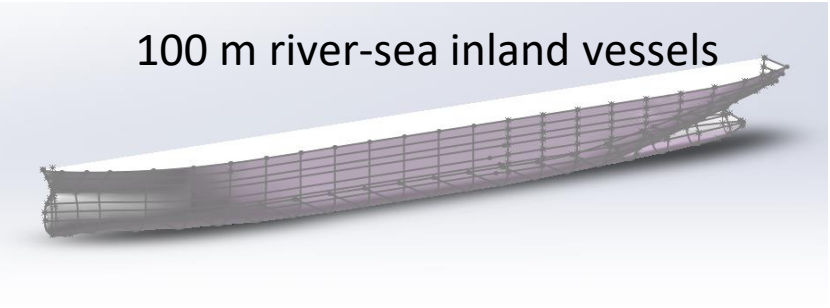
Creation of a Virtual Ship

- We have data for more than 20 inland vessels and 10 seagoing ships and more are coming …
- The modular type mathematical models for motions have been validated with 7 different ships comparing with free-running test results and more are coming…
- We have the ability to use CFD tools to analyse the hydrodynamic performance of ships and facilities to validate them …

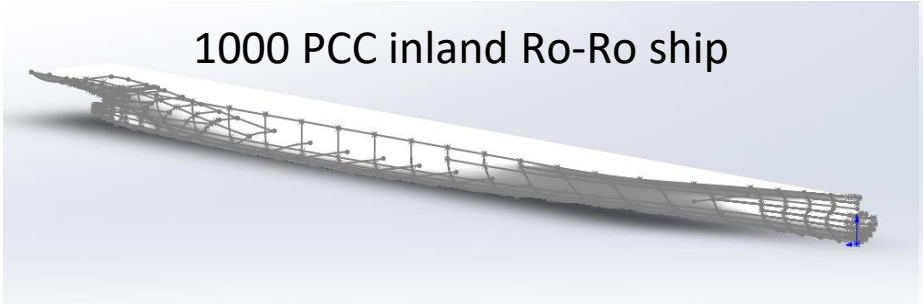
Inland ferries



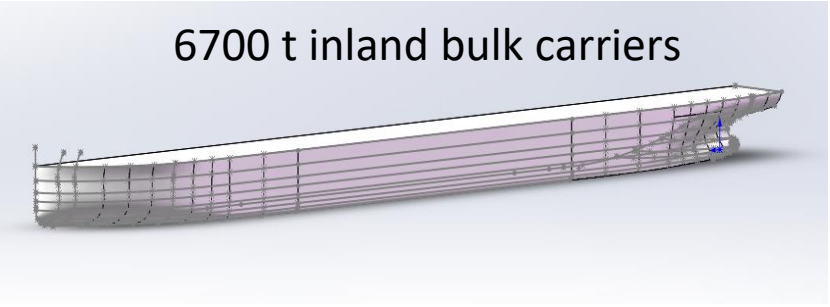
100 m river-sea inland vessels

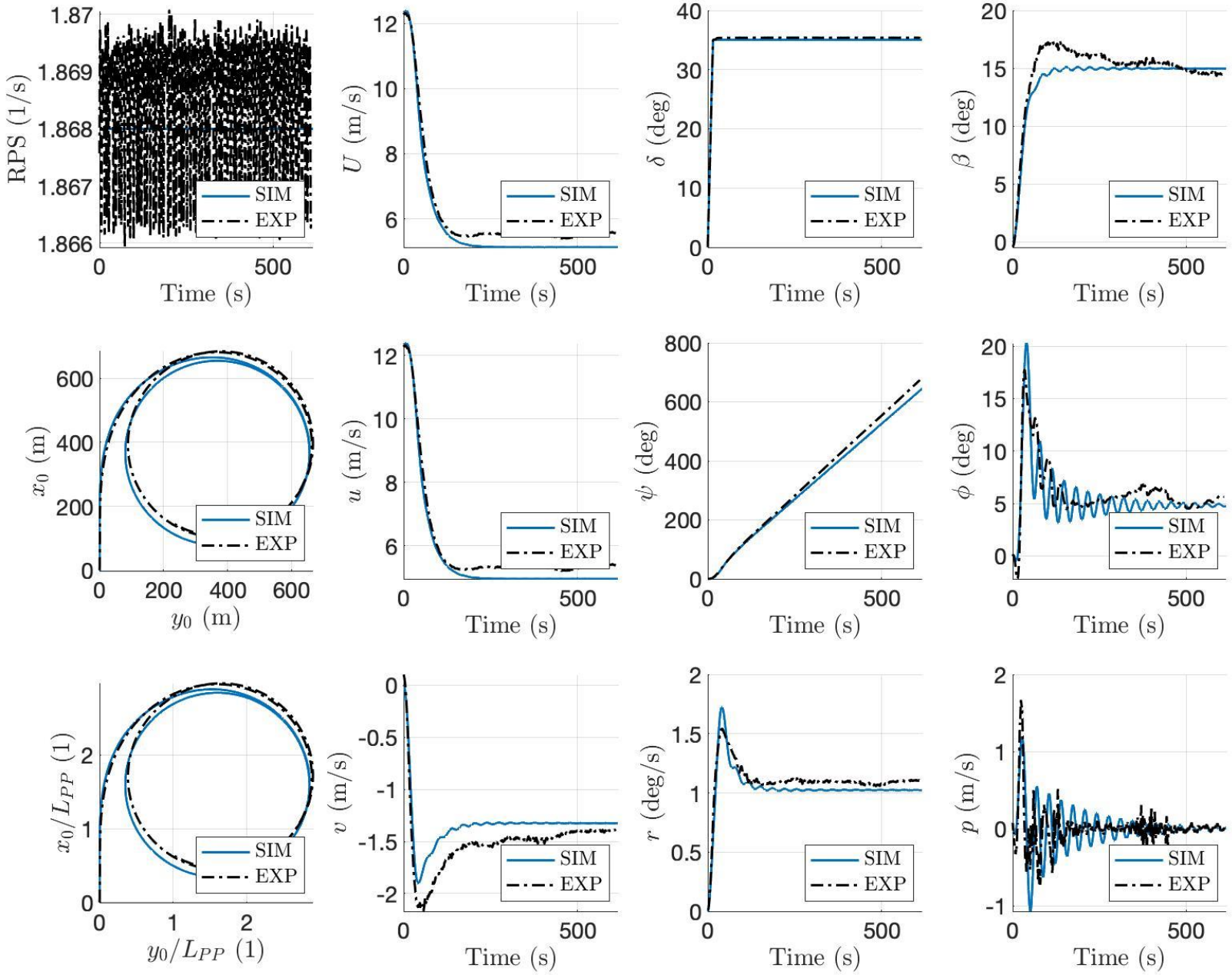


1000 PCC inland Ro-Ro ship



6700 t inland bulk carriers




RPS (1/s)
Time (s)
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U (m/s)
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ψ (deg)
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x_0/L_{PP} (1)
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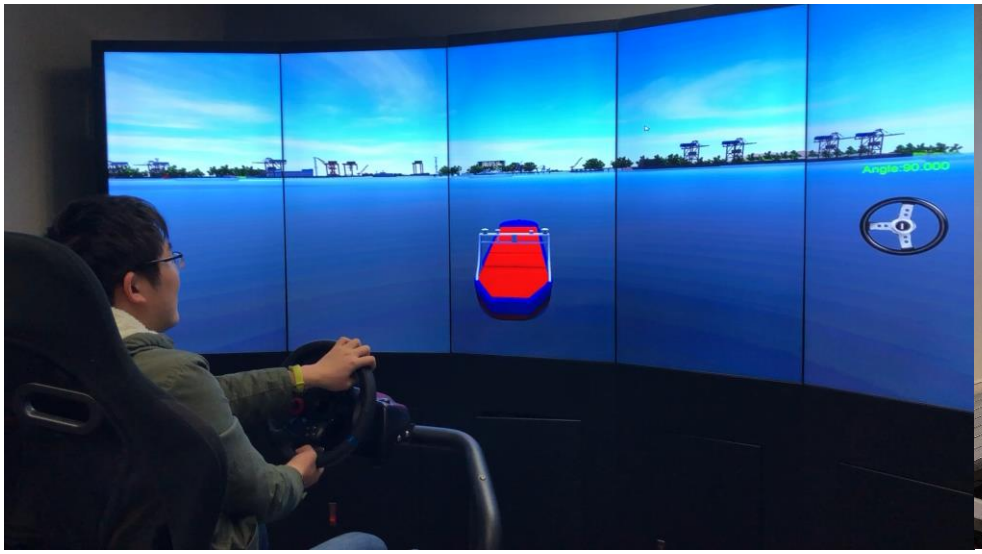
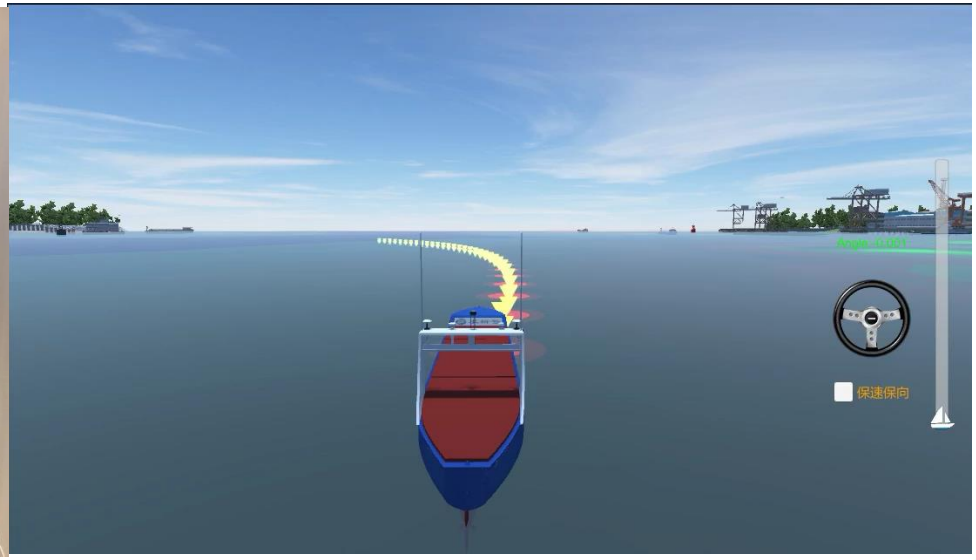
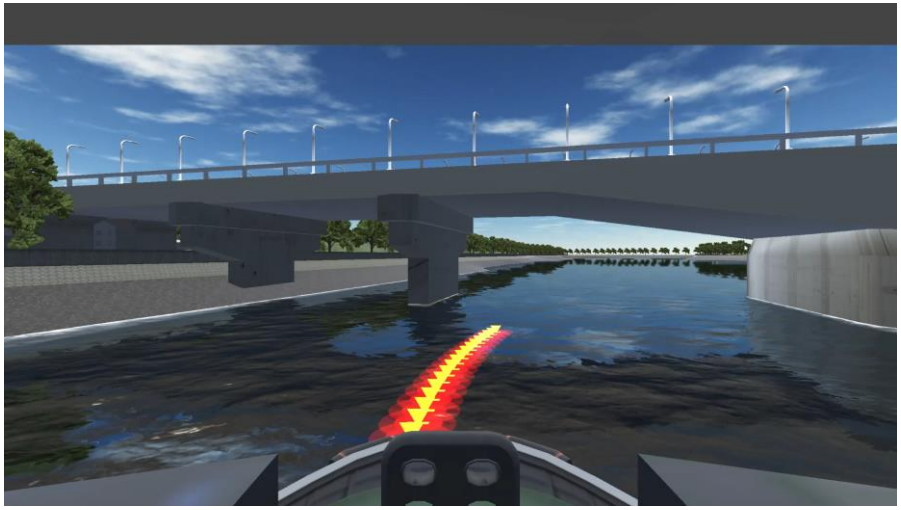
v (m/s)
r (deg/s)
p (m/s)

Virtual-real Interaction Test Platform

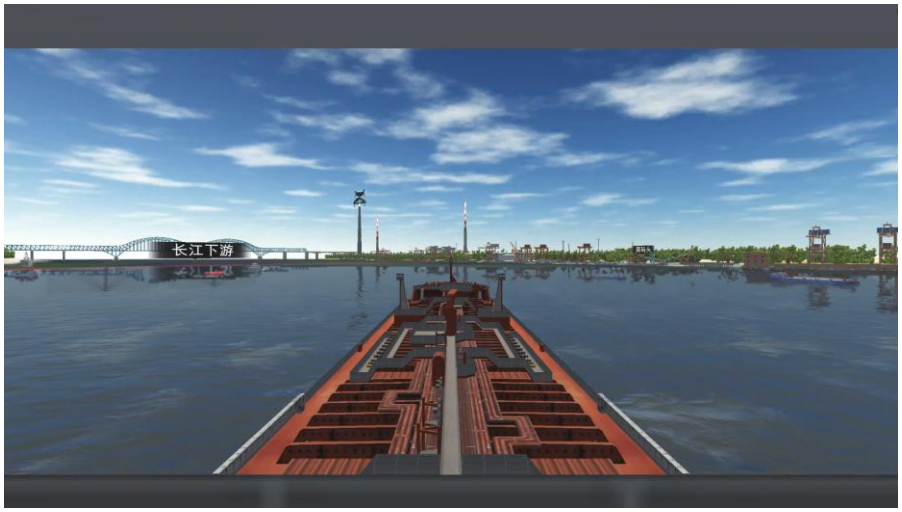




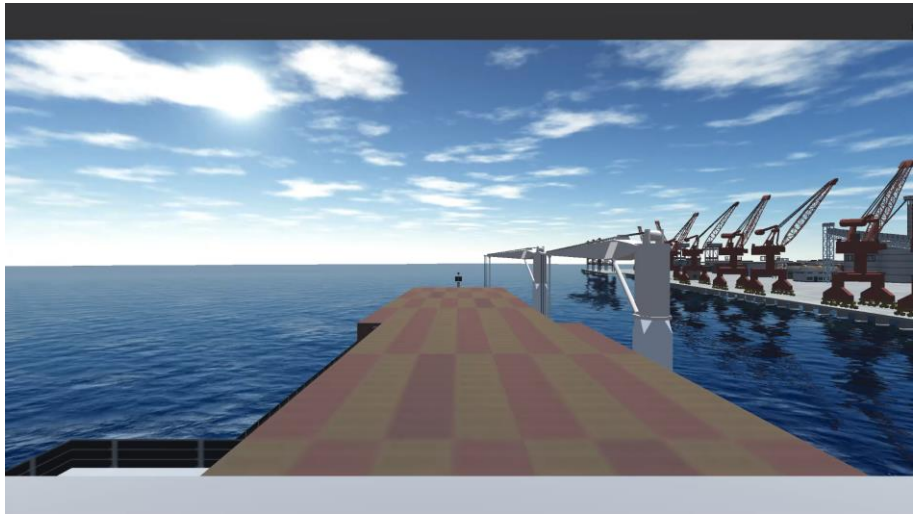
Virtual-real Interaction Test Platform



Han River-Wuhan



Yangtze River-Nanjing



Tianjin Port

Shenzhen Port

Application of the NBS to Virtual-real Interaction test

Zhuhai to develop China's first autonomous ship test ground

FEBRUARY 12TH, 2018 JASON JIANG (HTTP://SPLASH247.COM/AUTHOR/JASONJ/)

GREATER CHINA (HTTP://SPLASH247.COM/CATEGORY/REGION/GREATER-CHINA/), TECH (HTTP://SPLASH247.COM/CATEGORY/SECTOR/TECH/)

0 COMMENTS (HTTP://SPLASH247.COM/ZHUHAI-DEVELOP-CHINAS-FIRST-AUTONOMOUS-SHIP-TEST-GROUND/#RESPOND)

China's southern city of Zhuhai has commenced the construction of a test ground for autonomous ships as part of its plan to develop an industrial platform in the new sector.

The Wanshan Marine Test Field, which will cover a total area of 771.6 sq km, will become the largest autonomous ship test ground in the world. It will allow the testing of technologies such as autonomous steering and obstacle avoidance.

SAFETY4SEA

China builds Asia's first autonomous ship test area

in Major issues, SMART4SEA 12 February 2018

China's first smart ship / Credit: LR

China has initiated construction of Asia's first testing facility for autonomous vessels in Zhuhai, Guangdong province, Saturday, local media reported.

The Wanshan Marine Test Field is a a 225 square nautical mile zone, where operators can test autonomous steering and obstacle avoidance, according to China.org. As such, the test field will be the also the largest in the world.

As informed, nearby islands will feature comprehensive infrastructure, such as communications networks and navigation radar, in order to provide a realistic test environment to meet the demands that come with testing different types of ships.

A joint project between Zhuhai municipal government, China Classification Society (CCS), Wuhan University of Technology, and YUNZHOU-TECH, the test field is expected to be the main base for research in Chinese unmanned ship technology over the coming three to five years.

This latest development is part of China's steps towards advanced maritime technology. In mid-2017, the country launched the Unmanned Cargo Ship Development Alliance, chaired by HNA Technology Group Co, Ltd., and including ABS, CCS, China Ship Research & Development Institute, Shanghai Marine Diesel Engine Research Institute, Ltd, Hudong-Zhonghua Shipbuilding (Group) Co., Ltd, Marine Design Research Institute of China (MARIC), Rolls-Royce, and Wartsila.

The collaboration aims to establish technology and regulatory standards, assess of the environmental impacts, verification and inspection services for the industry and th ercialization of manned vessels.

HOME SAFETY SEAFARERS SECURITY ACCIDENTS SMART4SEA ALERTS SHIPPING OPINIONS EVENTS SAFETY4SEA+ NEWSLETTER

In December 2017, China also launched its first smart ship designed by Shanghai Merchant Ship Design and Research Institute (SDARI) and built at Guangzhou Wenchong Shipyard Co., Ltd (GWS), a subsidiary of China State Shipbuilding Corporation (CSSC). The vessel 'Great Intelligence', a 38,800 dwt modified version of the Green Dolphin fuel-efficient Bulk Carrier concept, is the pilot smart ship project within China.

What is more, in late 2017, the world's largest automated terminal started operations in Shanghai, under the fourth phase of the Yangshan deep-water port.

Autonomous shipping has been seeing a growing industry interest in the last years and North Europe has been generally at the centre of autonomous vessels test areas development. Specifically, Norway has taken the lead in 2017, with the introduction of two test bed areas for testing of autonomous vessels in 2017 in Horten and in Storfjord, after the first at the Trondheim fjord, in late 2016. Finland also inaugurated in late summer the opening of the Jaakonmeri autonomous maritime test area, the first to be globally open for such purpose.

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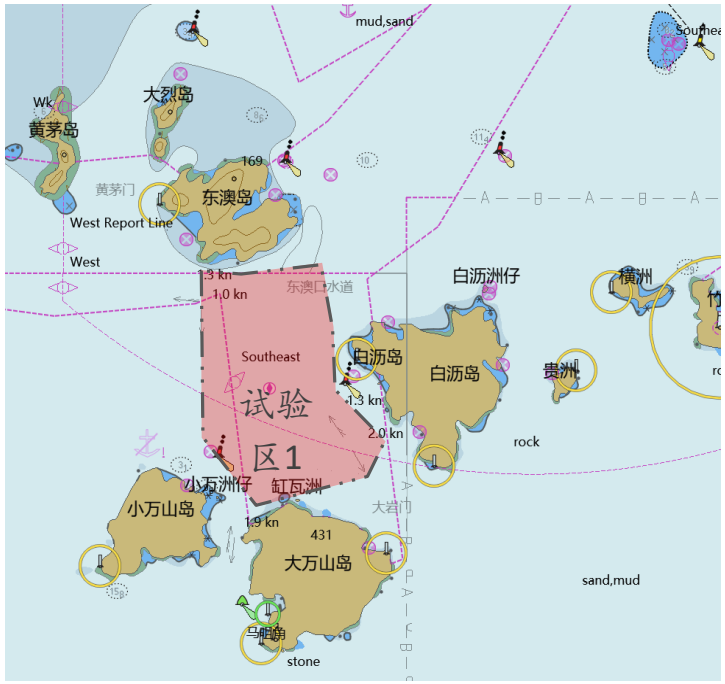
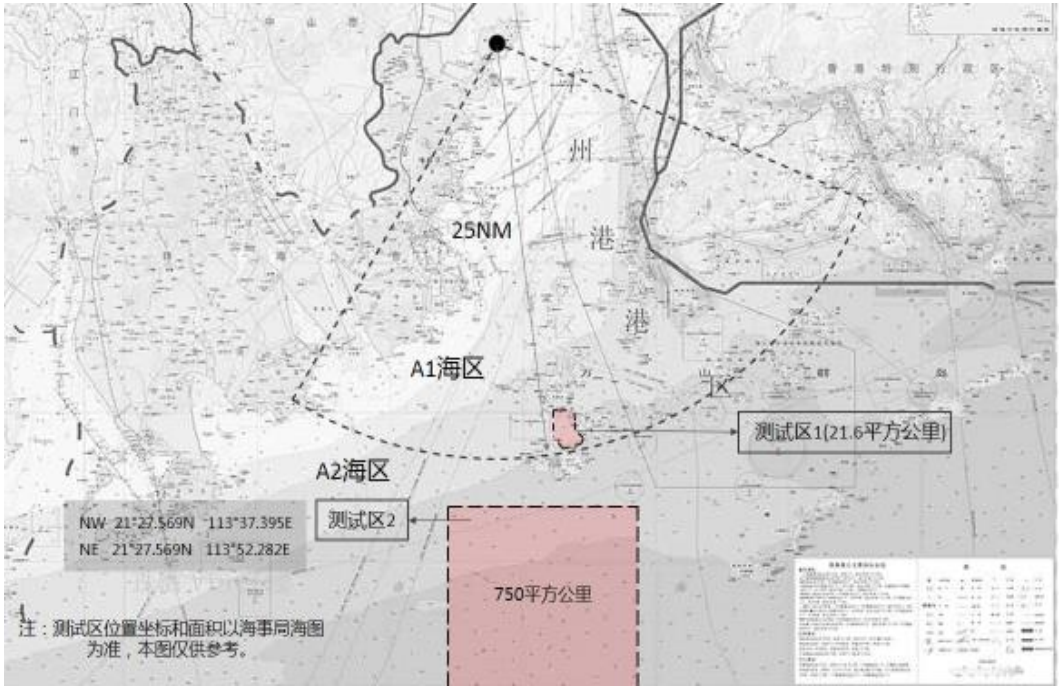
Oh behave!

Application of the NBS to Virtual-real Interaction test

Test bed for smart ships in Zhuhai, China





The construction of the world largest and the first test bed for smart ships in Asia, Zhuhai Wanshan test bed for unmanned ships, started on February 10th, 2018. The first stage will be located among four islands in Wanshan, which has an area of 21.6 km^2. The second stage will be set to the south of the first stage. The area of the second stage test bed will be 750 km^2.

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Remote-control test platform

Development of Navigation Brain System in the East Lake Wuhan, China

Test platform for remote control and autonomous navigation

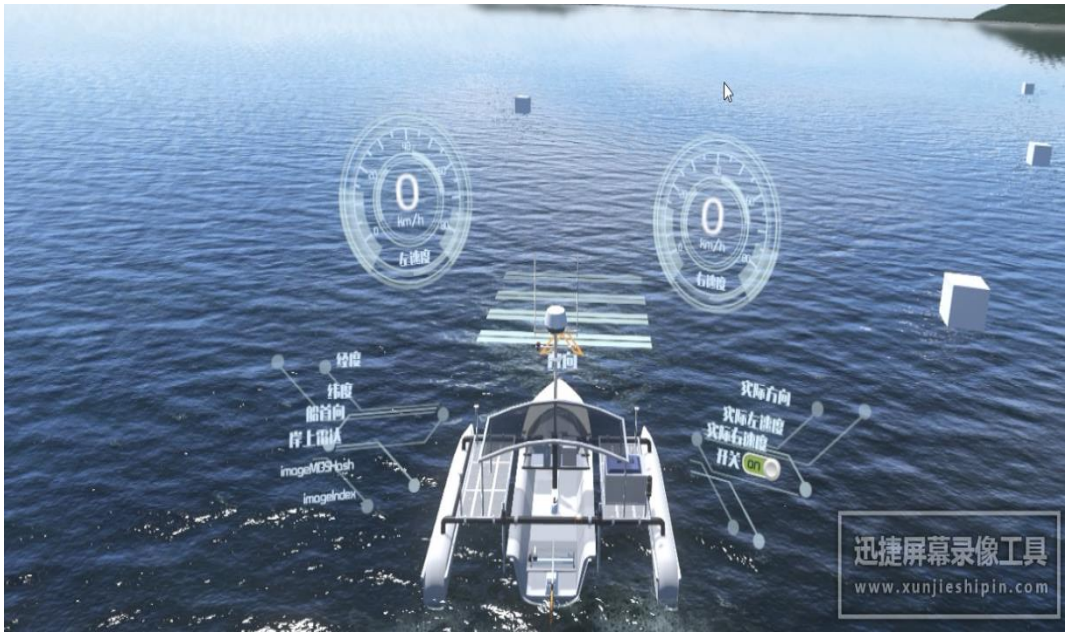
Remote-control test and VR applications

In 2017, …

- A six-degree motion platform has been built with VR.
- Remote-control function has been fulfilled through 4G and tested with a distance of 20 km.

Command Input

Real Feedback



Platform for Virtual Test and Remote Control

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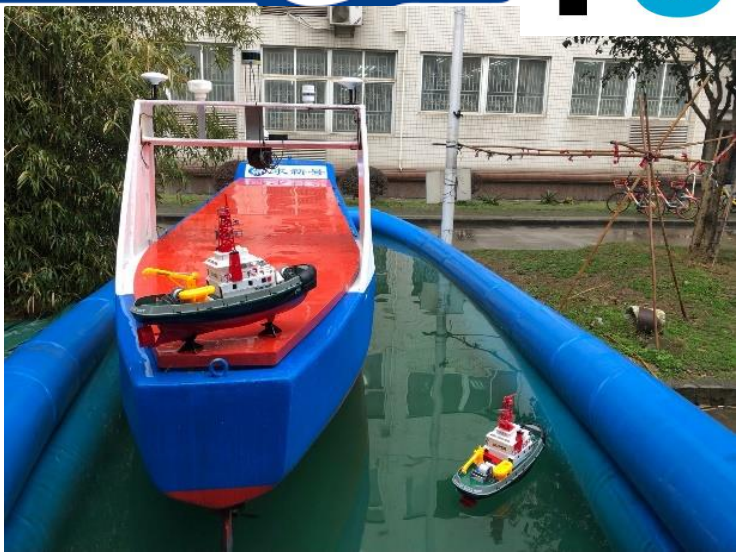

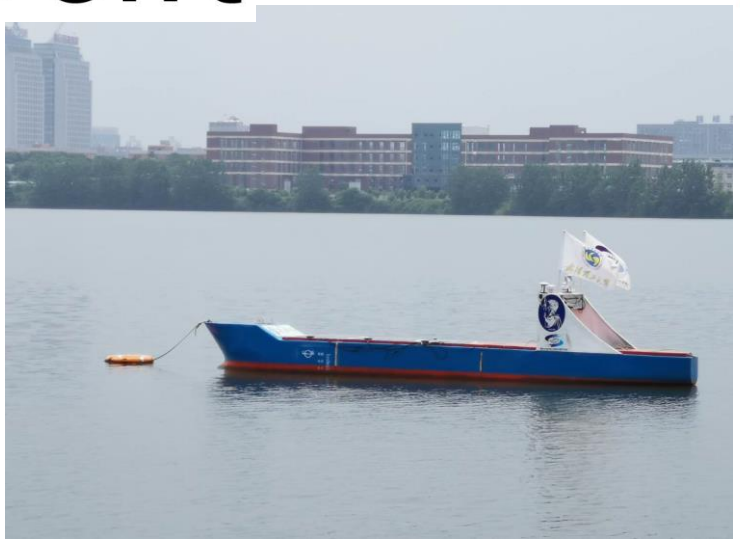

Remote Control Platform

Based on the Navigation Brain System, **in 2019**, an interface has been developed with a 7 m model-scale ship in the East Lake in Wuhan with a moveable remote-control platform. Remote-control tests have been performed from Beijing and Nanjing to Wuhan with a distance longer than 2000 km.

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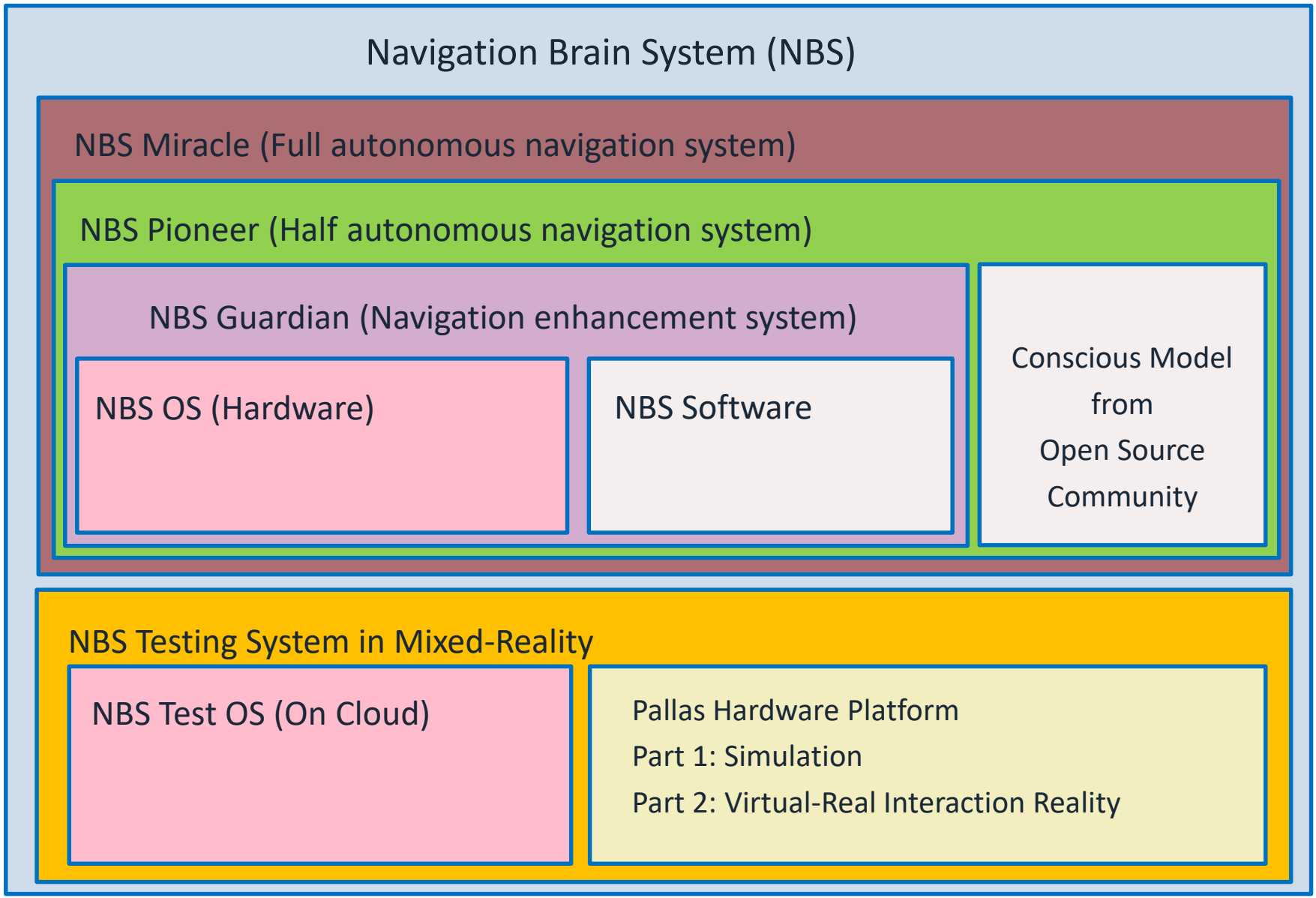
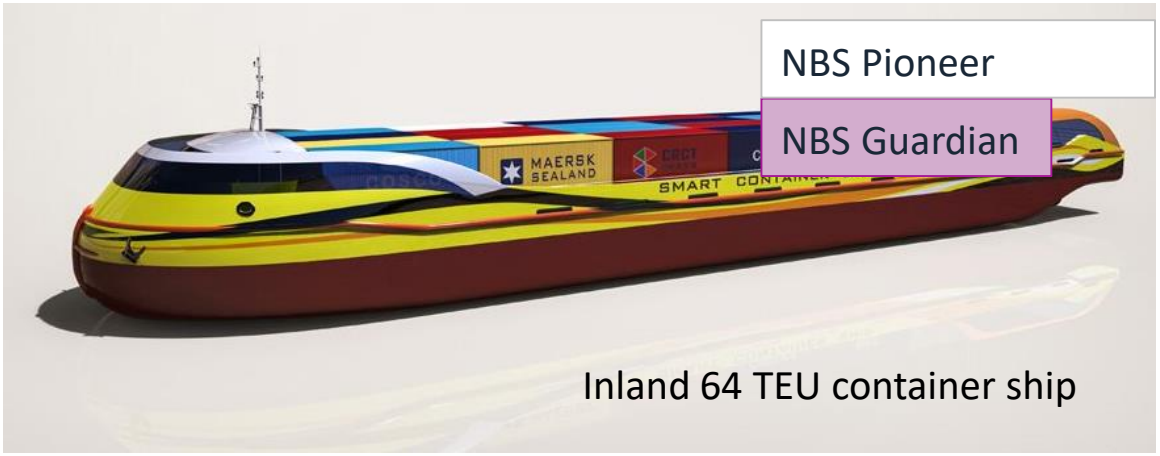
Family of the Navigation Brain System



Running projects



What do we need towards autonomous ships?

- Small to large and inland to sea …
- Full ability of environment perception …
- Integrated maneuvering models …
- Robust control algorithms …
- Electric based engines and maintenance free engines …
- Artificial Intelligence …
- A lot of money …
- Friends to cooperate

Let us cooperate

Let us cooperate

Paladin Operation System for Software and Pallas for Hardware

- Leader: Xin-ping Yan
- Maintainer status: maintained
- Maintainer: Peng Wang
- Author: Feng Ma, Jia-un Liu, Peng Wang, Yuanchao Hu, Shuwu Wang, Shije Li
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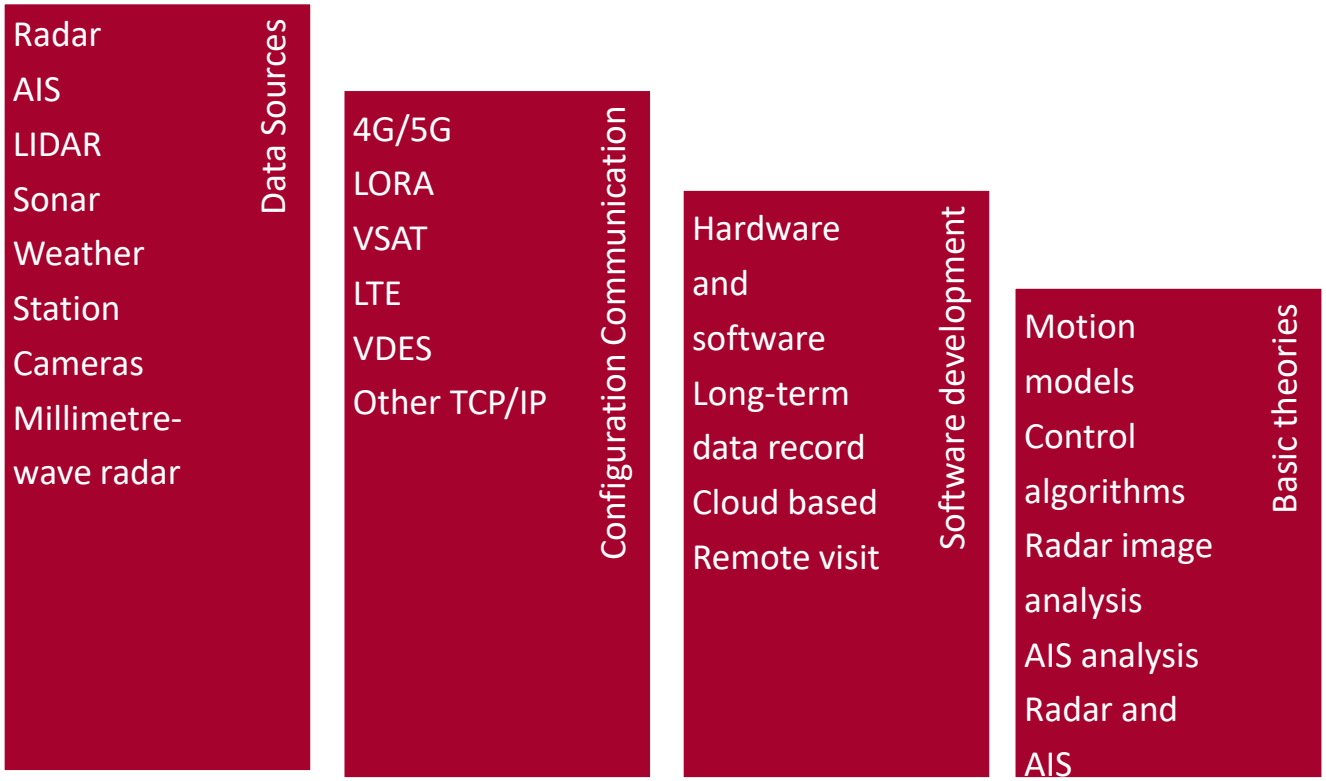

Thank you for your attention!

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