Developments of Smart Ships in China and Thoughts on the Safety of Smart Ships

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1. Development of Smart Ships in China
2. Applications of Smart Ships in WUT
3. Thoughts on the Safety of Smart Ships
4. Conclusions
MIIT—High-tech ship special project

- In Dec, 2016, MIIT published the handbook on High-tech ship project
- Launched the Smart Ships Vision 1
- Including: energy management, machinery maintenance, cargo monitoring, automatic navigation and ship-shore communication.
In December, 2015, CCS published “Smart Ship Regulation”.

It specifies the requirements on smart navigation, smart hull, smart engine room, smart energy management, smart cargo management, and smart integrated platform.
Innovation union on smart ship testing

- In March 31, 2017, the first meeting of innovation union on smart ship testing was held in WUT.
- Representatives from SSSRI, CTTIC, CCS, Oceanα, Nanhua, Zhongyuan electronics and WUT discussed the development of the innovation union.

1st preparatory meeting
In June, 2017, alliance for development of unmanned cargo ships was founded. It is the first alliance on unmanned ships in China, include: HNA, CCS, SSSRI, RR, ABS, etc, 19 units. In 2020, the first unmanned cargo ship will be built.
In February 10th, 2018, Zhuhai City, CCS, WUT and Yun Zhou Tech started on the construction of the world largest and the first test bed for smart ships in Asia, Zhuhai Wanshan test bed for unmanned ships. The first stage will be located among four islands in Wanshan, which has an area of 21.6 km². The second stage of the test bed will be will be 750 km².
Development of Smart Ships in China

Test bed for smart ships in Zhuhai, China

Model test
Dock
Terminal
Test bed
Full-scale ship test
Test scenario
Virtual test
Virtual test
Model test
China Building Asia’s 1st Test Area for Autonomous Vessels

China has started the const test field for autonomous si Guangdong.

The project will be the first of its could become the world's largest field for unmanned surface vehi according to Zhuhai China.

Expected to be the country's mai research into autonomous ship t coming three to five years, the W

Test Field will provide an area of 771 square kilometers.

The test field would enable the testing of technologies such as autonomous obstacle steering. China.org.cn reported.

As informed, the project is a result of a partnership between Zhuhai government, Chi Society (CCS), Wuhan University of Technology and Zhuhai Yunzhou Intelligence Tecl

Last year, industry bodies in China, led by HNA Technology Logistics Group and CSS unmanned cargo ship development alliance. The alliance is founder and facilitator o product rules, in addition to organizing and leading future development of unmanned Shipping.
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Applications of Smart Ships in WUT

1. Development the Components of Navigation Brain System
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- Video
- Millimeter wave radar
- Forward sonar
- Side scan sonar
- Laser radar
- Ship whistle
- Noise
- Posture
- Current
- Wind direction
- Hull structure state
- VIIF
- BeiDou positioning system

- Motion system
  - Driving experience
  - Navigation rules
  - route planning
  - Speed controller
  - Heading controller

- Interactive system
- Information understanding and transformation
- Behavior cognition
- Posture cognition

- Vision system
- Auditory system
- Tactile system
- Positioning system

- Computing server
2. Development of the test ship for Navigation Brain System in the East Lake Wuhan, China

- Under actuated propulsion
- Complete set of sensors
- Multiple obstacles avoidance

Test platform for remote control and autonomous navigation
Based on the Navigation Brain System, the remote control model has been developed in the campus of Wuhan University of Technology.

The distance between the East Lake and our campus are 20 km.

Do the smart ship remote control test.
4. Practical Applications of Unmanned Boats

- Different types and scales of autonomous boats have been developed in WUT.
- The scales cover 3 m, 5 m and 7 m. These boats have been used for water sampling, channel survey, and port portal in the companies.
5. Navigation Drive Aid System for Ferries in Nanjing, China

Applications of Smart Ships in WUT
5. Navigation Drive Aid System for Ferries in Nanjing, China

Navigation Drive Aid System based on Ship-Shore Coordination
5. Navigation Drive Aid System for Ferries in Nanjing, China
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Thoughts on the Safety of Smart Ships

Components of a Smart Ship

- **Communication System**
  - Provide ship-to-ship and ship-to-shore communication.

- **Ground Station**
  - Provide remote-control, supervision, assistance and inspection from shore.

- **Ship Station**
  - Integrate whole ships information and response to the shore station control orders.

- **Data Collection System**
  - Use sensors, radar, GPS, IMUs, LiDAR, camera, and sonar to measure and monitor information of the ship and the environment around it.

- **Guidance, Navigation, and Control**
  - Generate and follow trajectories based on missions and navigation environment. Perform automatic collision avoidance.

- **Test and Measurement**
  - Include test and measurements during the design process and life-cycle system monitoring.

- **Manoeuvring System**
  - Propeller-rudder system
  - Azipod thrusters
  - Bow and stern thrusters

- **Energy Source**
  - Wind
  - Solar
  - Wave
  - Battery

- **Hull Form**
  - Single-hull (Kayak)
  - Twin-hull (Catamaran)
  - Triple-hull (Trimaran)

- **Propulsion System**
  - Electric engines instead of diesel engines.
Thoughts on the Safety of Smart Ships

1. Reliability of the Energy Sources
2. Reliability of the Propulsion System
3. Reliability of Data Collection and Communication
4. Reliability of Ship Hull
5. Reliability of Ship Maneuvrability and Control
6. Reliability of Remote Control and Cyber Security
Thoughts on the Safety of Smart Ships

1. Reliability of the Energy Sources

◆ The safety of battery & energy storage

- Battery and electric drive technology are widely used in automobiles, but once accidents occur, it will result in devastating consequences.

- The application of battery to the ship power system will greatly improve the dynamic response performance of the ship and meet the requirements of environmental protection.
Thoughts on the Safety of Smart Ships

2. Reliability of the Propulsion System

- Safety of machine powered by dual fuel
  - The structure of the LNG-diesel hybrid propulsion system is more complex, and its reliability needs to be considered in the design phase.
  - There are challenges such as safety monitoring, fault diagnosis and other problems during the operation of LNG-diesel hybrid propulsion system.
Thoughts on the Safety of Smart Ships

2. Reliability of the Propulsion System

Electric propulsion with Rim Driven Thruster

Traditional PRS

Proposed RDT

This double-ended ferry has been upgraded with an eagerly awaited innovation:

Two 380 kW azimuth RDT1500s delivered by Brunvoll
3. Reliability of Data Collection and Communication
The strong hull structure is the key factor to ensure the safety of ship navigation, especially in bad sea conditions.

Unmanned ships can go to sea in a more severe condition. The higher requirement for the design optimization of the hull structure should be proposed.

The hull line and layout can be further streamlined and optimized because of no need to consider the personnel supporting cabin.

Thoughts on the Safety of Smart Ships

4. Reliability of Ship Hull
• The ship motion is performed in three dimensional space, and its characteristics are related to loading, navigation environment and sailing speed, etc.

• The large scale of ship, big inertia, difficult controlling, high requirement for forecast and high control precision, bring challenges for the practical application.

• The key technologies of autonomous navigation, such as independent collision avoidance and independent berthing, have put forward higher requirements for the perception of ship maneuverability and the design of controller.
6. Reliability of Remote Control and Cyber Security

Thoughts on the Safety of Smart Ships

Remote and autonomous operation

We are at the dawn of the Ship Intelligence era

Unmanned ships will be the most fundamental change in shipping that we will experience
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4 Conclusions

- Smart and unmanned ships are the developing trends for the marine technology in the future.
- The roadmap of the smart ships would be inland vessel, coastal vessel, and ocean going ship.
- A new design concept of Navigation Brian System for smart ships is proposed.
- There are still some challenges on the safety of the smart ships, and they need to be solved for practical applications.
Thanks

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