Developments toward the unmanned ship

Information on Ships - ISIS 2012, Hamburg, Germany, 30 - 31 August 2012

Ørnulf Jan Rødseth, Research Director
MARINTEK Dept. Maritime Transport Systems
OrnulfJan.Rodseth@marintek.sintef.no

Hans-Christoph Burmeister, Research Associate
Fraunhofer Center for Maritime Logistics and Services CML
Hans-Christoph.Burmeister@cml.fraunhofer.de

http://www.unmanned-ship.org
Content

- Introduction to MUNIN
- Rationale for unmanned ships
- Main problems with unmanned ship
- MUNIN approach
- Conclusion and summary
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Introduction to MUNIN

Munin ("mind") is one of Odin's two ravens flying out in the morning and reporting news of the world to their master in the evening.

Hugin ("thought"), the other raven, is also the name of a commercially successful autonomous submarine (AUV).

Here, MUNIN is the name of a new EU project researching the unmanned, autonomous ship.
Partners in MUNIN

- Fraunhofer CML (DE) – Research, Coordinator
- MARINTEK (NO) – Research
- Chalmers (SE) – University
- Hochschule Wismar (DE) – University
- Aptomar (NO) – Industry
- MarineSoft (DE) – Industry
- Marorka (IS) – Industry
- University College Cork (IE) - University
Project details

- Duration: 01.09-2012 – 31.08.2015
- Funding: 2.9 million EUR
- Activity code: SST.2012.5.2-5:
  E-guided vessels: the 'autonomous' ship
Objectives

- Develop and test unmanned ship concepts
- Main technical investigations on
  - Technical maintenance for high availability
  - Navigation support for unmanned bridge
  - Remote operations, shore coordination, including VTS/Pilot/SAR
- Base case is medium size dry bulk carrier
- Verify concept in system of simulators
- Examine legal and contractual constraints
- CBA and applications in today's shipping as well as other ship types
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WaterBorne TP

Route Map EO 3 Autonomous Ship

- **PILLAR 1**: Serious ship accidents in EU waters and by European vessels globally will be extremely remote.
- **PILLAR 2**: Ships designed and built in Europe will be crash-worthy and will be able to operate and survive under the most severe conditions (e.g., freak waves, ice, etc.).
- **PILLAR 3**: Ships built in Europe will be equipped with an onboard system for performance monitoring, which are supporting safe operation and lifecycle maintenance.
- In 2020, autonomous monitoring, identification, communication and vessel traffic management systems will be operational around Europe, to improve the coordination and efficiency of operations.
- In 2020, the cost for sustainable, safe, and secure waterborne transport will continue to be clearly lowered than other transport modes.

**TODAY**

- STRATEGIC RESEARCH AGENDA
- ONGOING PROGRAMMES
- DEVELOPMENT MILESTONES
- EXPLOITATION OUTCOMES
- VISION TARGETS

**RESEARCH TOPICS**

- Innovative Marine Equipment & Systems
- Tools for Accelerated Innovation
- Next Generation Production Processes
- Effective Waterborne Operations
- Interoperability between Modes
- Traffic Management Strategies
- **2.2.3.5 Ship/Shore Systems Integration**
- **2.2.1 Life Cycle Philosophy**
- **2.2.12 Technology Base**
- **2.2.13 Future Advanced Hull Structure**
- **2.2.14 Innovative Materials & Systems**
- **2.2.15 Human Factors in the Shipbuilding Process**
- **2.2.14 Leading Edge Integrated Shipbuilding Production**
- **2.2.14 Electrical Power Networks**
- **2.2.15 More Efficient Propulsion**
- **2.2.14 Class Approval of Remote Operation**
- **2.2.14 Integrated Propulsion & Hull Design Tools**

**2020**

- Short Sea Ship Concept Demonstrator
- Autonomous Ship
- Integrated Propulsion & Hull Design Tools
- Certification of New Materials

**FP7**

- ADOPT
- DLR
- FLAGSHIP
- SAFETYON
- HAFTRONIC
- CONSAR
## Slow steaming

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Distances by [www.vesseldistance.com](http://www.vesseldistance.com)
Autonomous Slow Steaming

- Environmentally
  - Reduce CO\textsubscript{2} emissions with 54%

- Economically
  - Offset increased crew costs

- Societal
  - Make crew available for more demanding tasks, closer to home, offset lack of crew, increase job attractiveness
Technology also applicable for today's ships

- Improved sensor and detection systems
  - Less accidents, less stress for seafarer

- Improved technical maintenance strategies
  - Less accidents, less off-hire

- Improved ship-shore cooperation
  - Better crew support, relieve crew of excess work, ashore ‘ship-sitting’
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Communication technology and information transfer

- Dependent on trade area and cost one have to expect varying degree of communication service (bandwidth and latency)!

AMVER July 2012: www.amver.org
Lookout and collision avoidance

- Arpa and AIS exist on board.
- Small object detection radar, IR cameras, low light cameras etc. are available.

Key challenges are to integrate sensors and to classify objects automatically.
System robustness

- Today ship safety is to some degree based on the ability to repair equipment during voyage.
- Autonomous ships need high confidence level for no critical failures during sea leg!
- Very high reliability and fail-to-safe procedures required!

New approaches to component redundancy as well as preventive maintenance are required.
Ship-shore coordination

- Ship operator needs a central operations centre ashore.
- Coordination with other entities when necessary:
  - Other (autonomous) ships
  - Pilot, VTS …
  - General ship reporting (FAL, SOLAS)
  - SAR
  - …
Legal and contractual issues

- Flag state jurisdiction without master?
- COLREGS?
- Insurance and liability?
- Safety at sea – SAR?
- ...

Probably the main problem:
It will take time before we see the first fully autonomous ship!
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From manned to autonomous
From manned to autonomous

Remote Ship
- Radar
- ECDIS
- Visual

Still requires substantial shore crew!

Automated Ship
- Radar
- ECDIS
- Visual

Not realistic today!

Action

Generic Alternatives
From manned to autonomous

Actual
Manned Ship
Radar
ECDIS
Visual...

Symbiosis
Autonomous Ship
Radar
ECDIS
Visual...

Action
Autonomy vs. uncertainty

Degree of autonomy

- Intelligent
- Autonomous
- Automatic
- Fail to safe
- Remote control

Degree of uncertainty

- None
- Simple and robust
- Flexible, known response
- Constrained freedom
- Full freedom

- Onboard route planning
- Collision avoidance
- Route keeping
- Emergency stop
- Shore side operation centre

MUNIN Focus
Main operational modes

Automatic
- Problem detected

Autonomous
- Cannot solve

Remote
- Lost contact
  - Operator back in control

Fail to safe
- Emergency response needed

Problem solved
Simulator configuration

- Anti-collision / autonomous nav.
- Efficient operation
- Improved system robustness.
- Health monitoring and planned maintenance

Bridge systems

Engine systems

Internet

VTMIS/Pilot

Fleet operations control

Remote VTS, pilot and SAR

Cooperative decision support

Remote operation

Improved operational procedures

Application to other shipping types

Efficient operation, Actual data, Improved ICT, Improved operational procedures, Application to other shipping types.
Simulator configuration

- Bridge systems
- Engine systems
- VTMIS/Pilot
- Fleet operations control

- Actual data
- Internet

- Anti-collision / autonomous nav.
- Efficient operation
- Improved system robustness.
- Health monitoring and planned maintenance
- Remote VTS, pilot and SAR
- Cooperative decision support
- Remote operation
- Improved operational procedures
- Application to other shipping types
Simulator configuration

**e-Maritime ICT Architecture**

- Bridge systems
  - Improved ICT architecture.
- Engine systems
  - Improved system robustness.
  - Health monitoring and planned maintenance
- VTMIS/Pilot
  - Remote VTS, pilot and SAR
  - Cooperative decision support
- Fleet operations control
  - Remote operation
  - Improved operational procedures
  - Application to other shipping types

- Actual data
  - Anti-collision / autonomous nav.
  - Efficient operation

**MUNIN**

(Sixth Framework Programme)
Simulator configuration

Bridge systems

Improved ICT architecture

VTMIS/Pilot

fleets operations control

Legal and contractual changes

Improved system robustness

Efficient operation

Engine systems

Anti-collision / autonomous nav.

Actual data

Actual data

Remote VTS, pilot and SAR

Cooperative decision support

Remote operation

Improved operational procedures

Application to other shipping types

Legal and contractual changes

Actual data

Actual data

Efficient operation

Improved system robustness

Health monitoring and planned maintenance

Actual data

Actual data

Bridge systems

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Is the autonomous ship possible?

- Technology is mostly available: Need to be integrated and improved

- Integration in maritime transport system is a challenge: Shore, other ships, SAR

- Legal issues and liability clearly a show stopper today
What will MUNIN contribute?

- Demonstration and tests of the technical issues
- Legal and cost-benefit analysis
- New technology also for today's ships
... and then the autonomous ship!