The MUNIN project
An overview

MUNIN Final Event
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http://www.unmanned-ship.org

SST.2012.5.2-5: Grant no. 314286
E-guided vessels: The 'autonomous' ship
The raven Munin
Odin‘s source of information

Hugin and Munin fly each day over the spacious earth.
I fear for Hugin, that he come not back, yet more anxious am I for Munin
Contents

1. **MUNIN origins:** Why an unmanned vessel?

2. **MUNIN concept:** How does it look like?

3. **MUNIN test-bed:** What has been investigated?

4. **MUNIN feasibility:** Is it the future?
WATERBORNE^TP

Autonomous Ship as European pillar
Definition
MUNIN’s autonomous ship

Autonomous ship
Next generation modular control systems and communications technology [that] will enable wireless monitoring and control functions both on and off board. These will include advanced decision support systems to provide a capability to operate ships remotely under semi or fully autonomous control.

Autonomous ship
No persons on board for whole or part of the voyage. The ship, with partial help from remote control, must be able to manage the voyage on its own.
MUNIN concept study
Handymax Dry Bulk Carrier

- **Duration:** 01.09.2012 – 31.08.2015
- **Funding:** 2.9 million EUR of budget 3.8 million EUR
  - Develop a concept for an unmanned merchant vessel
  - Validate concept in a simulator set-up
The MUNIN project
Consortium
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Rationale for unmanned vessels
Sustainability and short term use

Current challenges of maritime shipping:
- Highly competitive industry
- Lack of young professionals
- Rising ecological awareness

Autonomous ship as a long-term solution to:
- Reduce operational expenses
- Attract professionals
- Reduce environmental impacts

Human Error

- 35% Crew
- 65% Rest

Source: BIMCO/COSI estimate

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The MUNIN project
Autonomous capabilities required
Use Case
Dry bulk carrier on deep-sea-voyage

Reasons:
- Long deep-sea-voyage
- Low risk cargo
- Slow steaming attractiveness
MUNIN Vision
Autonomy and remote control
Main Challenge
Unmanned, but not out-of-the-loop

If \( x \) else
\[
a \rightarrow 2.5 \\
b = ! 3.04
\]
... {notify}
$\text{ship\_env}$
waiting...

![Diagram showing a flow of information and decision process with symbols and equations.](image-url)
Operational modes on-board
Restricted interaction must be respected

- Autonomous execution
- Autonomous control
- Remote control
- Remote monitoring
- Status intervention
- Remote control
The new MUNIN sub-systems

- Advanced Sensor System
- Shore Control Centre
- Maintenance Interaction System
- Remote Manoeuvring Support System
- Deep-Sea Navigation System
- Engine Monitoring & Control System
- Energy Efficiency System
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MUNIN Unmanned Vessel Test-bed
Integrated simulations for validation

Advanced Sensor System

Shore Control Centre

Maintenance Interaction System

Remote Manoeuvring Support System

Deep-Sea Navigation System

Engine Monitoring & Control System

Energy Efficiency System

Ship handling simulation
Sensors and autonomous navigation

From concept...

**Advanced Sensors System**
- Electronic lookout
  - Detect small objects
  - Detect weather phenomena

**Autonomous Navigation System**
- Op. decision-making
  - Avoid collisions
  - Ensure stability in harsh weather

**Shore Control Centre**
- Human element
  - Monitor voyage and vessel
  - Problem-solving
Sensors and autonomous navigation... to prototype implementation

Advanced Sensors System
 Electronic lookout
 - Detect small objects
 - Detect weather phenomena

Autonomous Navigation System
 Op. decision-making
 - Avoid collisions
 - Ensure stability in harsh weather

Shore Control Centre
 Human element
 - Monitor voyage and vessel
 - Problem-solving
Remote Control in special situations
From concept ...

Remote Manoeuvring Support System
‘Ship Feeling’
- Calculate response
- Visualize actual manoeuvring space

Shore Situation Room
Human element
- Direct control and steering
- Situation awareness
Remote Control in special situations … to prototype implementation

Remote Manoeuvring Support System

‘Ship Feeling’
- Calculate response
- Visualize actual manoeuvring space

Shore Situation Room

Human element
- Direct control and steering
- Situation awareness
Autonomous engine room
From concept ...

Autonomous Engine Monitoring and Control
Condition measurement
- Detect functional degradations
- Ensure efficiency

Shore Control Centre
Human element
- Maintenance planning
- Problem-solving
Autonomous engine room
... to prototype implementation

**Autonomous Engine Monitoring and Control**
- Condition measurement
  - Detect functional degradations
  - Ensure efficiency

**Shore Control Centre**
- Human element
  - Maintenance planning
  - Problem-solving
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Main Hypothesis on unmanned vessels

**MUNIN’s hypothesis:** Unmanned ship systems can autonomously sail on intercontinental voyages at least as safe and efficient as manned ships.

- The Autonomous Sensor Module can sense sufficient weather and traffic data to ensure navigation and planning function on autonomous ships and enable situation awareness in an operation room.
- A Deep-Sea Navigation System can autonomously navigate a ship safely and efficiently along a predefined voyage plan with respect to weather and traffic conditions.
- A ship engine can reliably operate for 500hrs without physical interference from a human in the ship’s engine room.
- The Shore Control Centre operator will be capable to monitor and control six unmanned ships at the same time.
Initial validation in-situ and in simulations conducted
Risk and cost assessment

Risk Assessment

Cost-Benefit Assessment

RISK
Collision
10^{-5} \rightarrow 10^{-6}

Foundering
10^{-1} \rightarrow 10^{-2}

Capital cost
Crew on board
Crew in SCC

Short term application
MUNIN long term vision

MUNIN
Legal and social assessment

Social Impact Assessment

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Legal and Liability assessment

The forth legal pillar
- Coastal State
- Flag State
- International Law
- **Controller State?**
It’s not IF, it’s only WHEN ...
Thank you for your attention

10th – 11th June 2015 • Hamburg • 53° 7,8’ N 009° 58,1’ E

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Is unmanned and autonomous shipping feasible? – And is it desirable?