MUNIN

MARITIME UNMANNED NAVIGATION THROUGH INTELLIGENCE IN NETWORKS

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AUTONOMOUS SHIP TECHNOLOGY OVERVIEW AND APPLICATION POTENTIALS

ADVANCED SENSOR MODULE

DEEP-SEA NAVIGATION SYSTEM

REMOTE MANOEUVRING SUPPORT SYSTEM

ENGINE MONITORING & CONTROL SYSTEM

ENERGY EFFICIENCY SYSTEM

SHORE CONTROL CENTRE

MAINTENANCE INTERACTION SYSTEM

Overview of MUNIN developments

The MUNIN project investigates concepts relating to fully or partially unmanned dry bulk carriers and determines the kind of technology required to facilitate automated ship operations. An unmanned merchant ship is what is called an 'industrial autonomous system', i.e. a system that needs to satisfy strict cost-effectiveness and safety requirements so that it can be allowed to operate in a real-world commercial environment. Scientific and military research will often put less emphasis on these criteria, which limits the applicability of results in other domains.

This ultimate objective is obviously a long-term goal, but the necessary sensor and control system technology can also be used to improve present ship operations. This brochure presents some of the anticipated applications.

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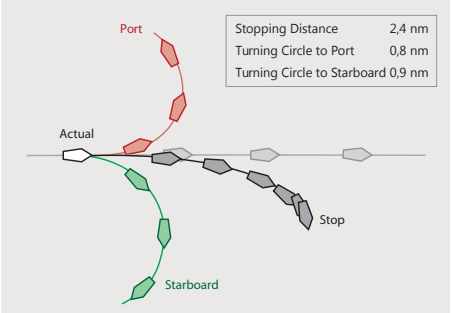
Dependable detection

The main function of the Advanced Sensor Module (ASM) is to maintain a proper lookout for ship traffic, obstacles and to monitor the environmental conditions in the vicinity of the ship.



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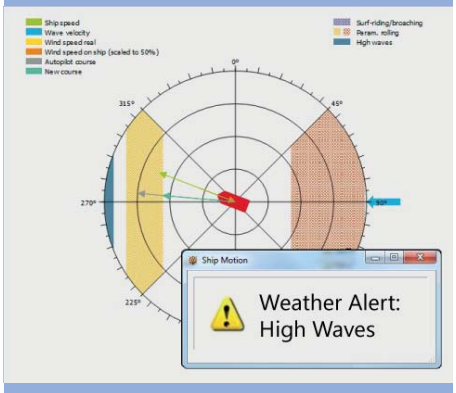

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The ASM collects data from navigational, meteorological and safety sensors. It then assesses this data to build a local map of objects and potential hazards. This approach fuses and correlates data from multiple sensors to reduce overall uncertainty and improve the quality and integrity of the so-called world perception model. This overall perception is used as a basis to determine appropriate actions under the prevailing conditions.

Safe navigation

Navigation is the activity of accurately ascertaining one's position as well as planning and following a route. In doing so, many factors need to be considered. These include internal aspects such as the ship's particulars and its condition as well as external ones such as the weather and traffic situation to operate safely and to obviate potentially dangerous situations. The Deep-Sea Navigation System (DSNS) helms a ship's bridge on trans-oceanic voyages without having crew on the bridge and operates in combination with the track pilot. Thus, the DSNS's main functions are to:

- Determine COLREG-obligations towards other ships
- Conduct COLREG-compliant collision avoidance manoeuvres, including manoeuvre of the last second
- Optimise trans-oceanic voyage plans with regards to weather
- Operate the ship safely in harsh weather conditions in accordance with the IMO weather guidance criteria.

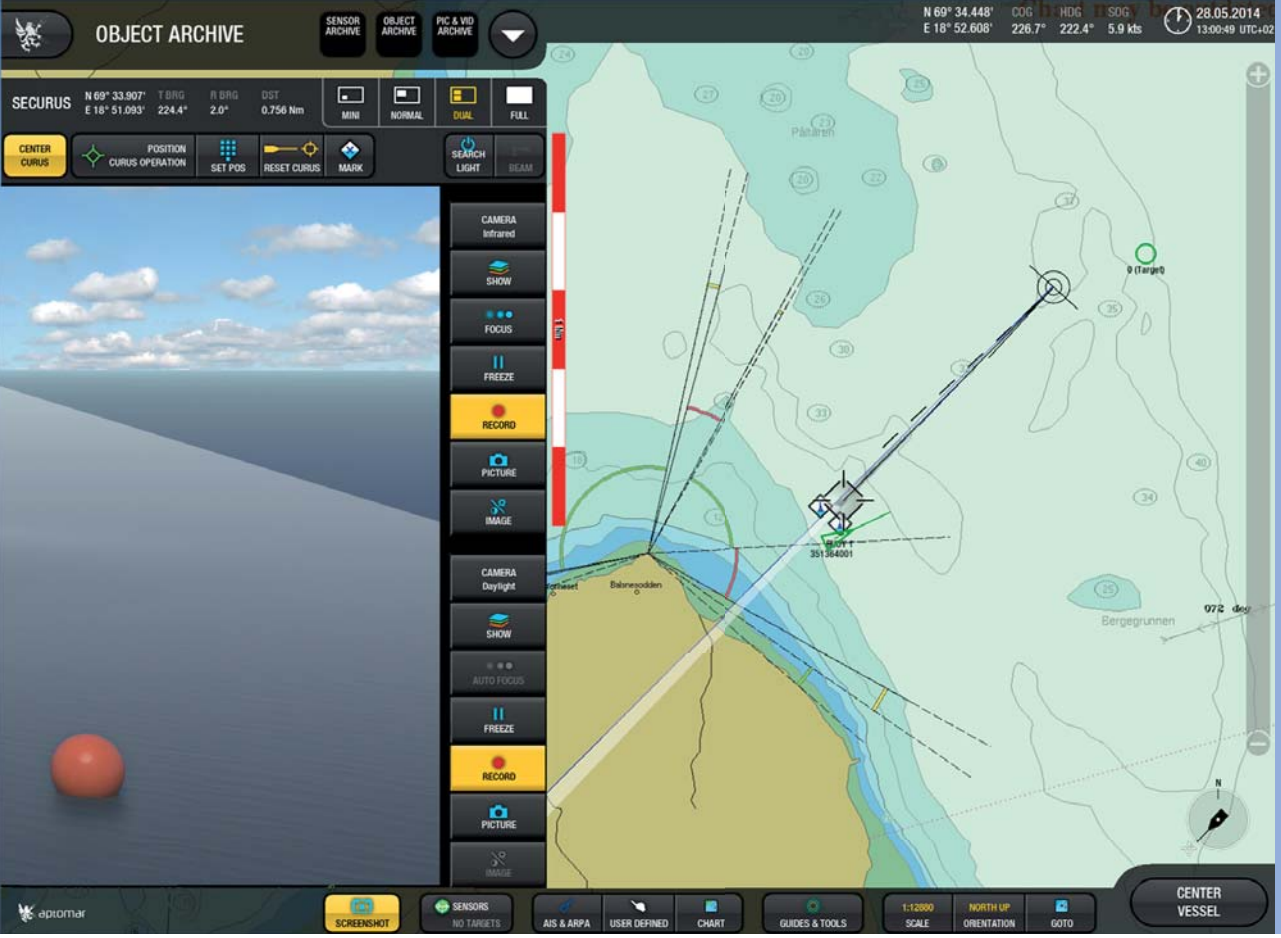
Predictable manoeuvring

In addition to collision avoidance and weather routeing, manoeuvring in narrow waters is of fundamental importance to safe and efficient ship operation.

To support this function from a shore-based control centre, MUNIN provides predictions of future ship movements resulting from various simultaneous rudder or engine manoeuvres. Enabling precise manoeuvring, the Remote Manoeuvring Support System (RMSS) calculates and displays the anticipated ship movements in terms of its limitations of manoeuvrability during the following manoeuvres:

- Current bridge handle settings
- Maximum turning circle to starboard side
- Maximum turning circle to port side
- Emergency stopping manoeuvre

as well as any combination of the above.



Reliable operation

Unmanned ship operation requires continuous performance monitoring of the main propulsion plant. The performance of the main engine is determined by its technical condition, operating conditions and operating mode.

If the correct performance parameters are selected, an immediate indication of critical changes in these conditions can be obtained. A critical part of the main engine is the tribological system between the piston, piston ring and cylinder liner. Damages in this complex can lead to a loss of propulsion. The MUNIN Autonomous Engine Monitoring and Control (AEMC) diagnostic system can be used to detect a number of different issues, e.g. broken, burned-on or even missing piston rings and the radial wear of piston rings. It also detects a thermal overload of the cylinder liner by washing of the lubricating film in high-humidity regions.

Efficient economising

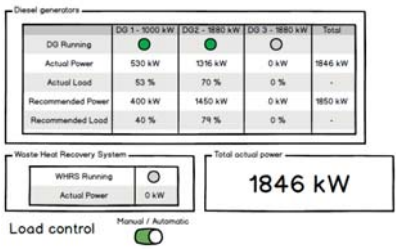
The Energy Efficiency System (EES) analyses the electrical power demand requirements of the ship. The machinery can then be run in the most efficient way, minimising the total specific fuel oil consumption of the available power producers. The EES also seeks to use waste heat recovery as much as possible.

Operational data is obtained from relevant systems and evaluated. The EES then sends optimal operating parameters for the electrical energy producers to the engine control systems. In addition, the EES compiles route leg-based reports on consumption, emissions and performance for ship owners, maritime authorities and component manufacturers.

Constant monitoring

Effective control of the ship engine processes requires the proper means to aggregate decision support information. Performance level trends must be monitored and kept within acceptable ranges. This is done by using selected indicators. By converting these indicators to Technical Condition Indexes (TCI) they immediately indicate when an action should be initiated to avert risks at the plant. By implementing a systematic and continuous assessment procedure, it is possible to obtain a rapid and extensive overview of the current state and the degradation trend of a system without the need to interpret too many details in various technical subject areas.

The TCI is used in many different ways to implement systematic and repeating assessments of the ship's machinery. The key strength of the TCI is their ability to spot trends, benchmark the indexes and enable the controller to take actions at an early stage to prevent unwanted effects.



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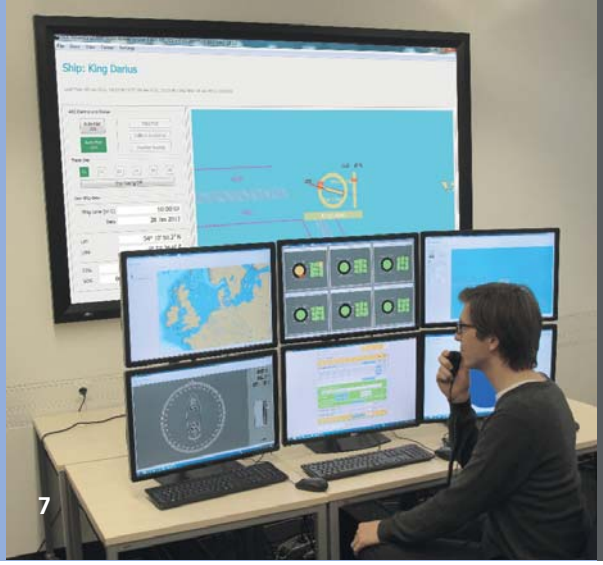

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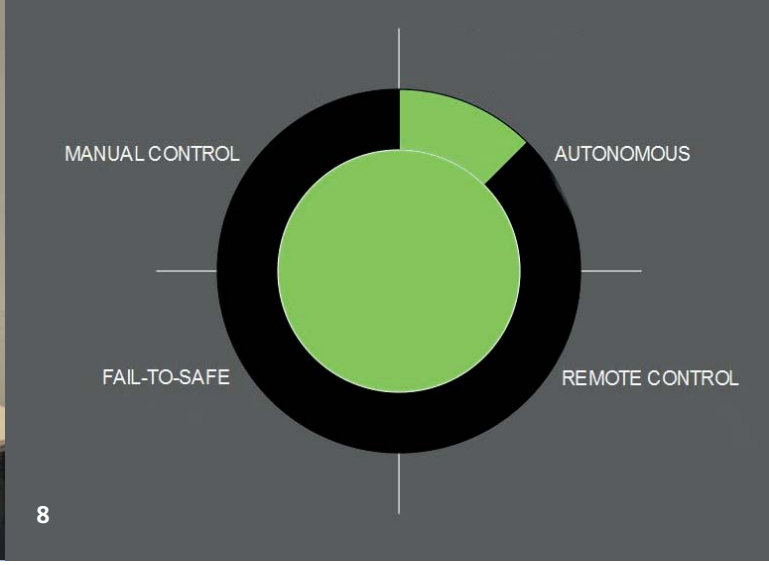

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European Commission

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Remote control

The Shore Control Centre (SCC) acts as a supervisory entity for a fleet of ships navigating in worldwide waters. Manned by highly qualified maritime professionals, the individual operators' main responsibility is to ensure a safe and efficient voyage for the assigned ships to be monitored. The main tasks of the SCC are:

- Planning detailed voyage itineraries and maintenance schedules
- Monitoring the progress made by the ships and the correct functioning of equipment
- Controlling ships either indirectly by defining certain degrees of freedom within which the systems operate within or directly by forwarding specific command values to be executed.

Satellite links ensure sufficient connectivity and allow for data exchange between the SCC and the fleet. Information updates are forwarded in fixed time intervals, are triggered by certain events or can be queried from ashore.
This approach aligns perfectly with the general trend for an ever-increasing demand for continually updated information by land-based stakeholders such as shipping companies and maritime administrations.

Test-bed for the unmanned ship

The introduced MUNIN prototypes are integrated into a state-of-the-art ship-handling-simulation environment, facilitating real-time and full-scale trials by qualified test personnel. This represents a unique opportunity to evaluate unmanned ship operations, shore control procedures and functionalities during development stage as well as to investigate the interaction of manned and unmanned ships.

This set-up primarily allows to test the validity of MUNIN's main hypothesis that 'unmanned ship systems can autonomously sail on intercontinental voyages at least as safely and efficiently as manned ships'. However, the short-term application potential of individual prototypes can also be assessed.

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