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Autonomous Shipping

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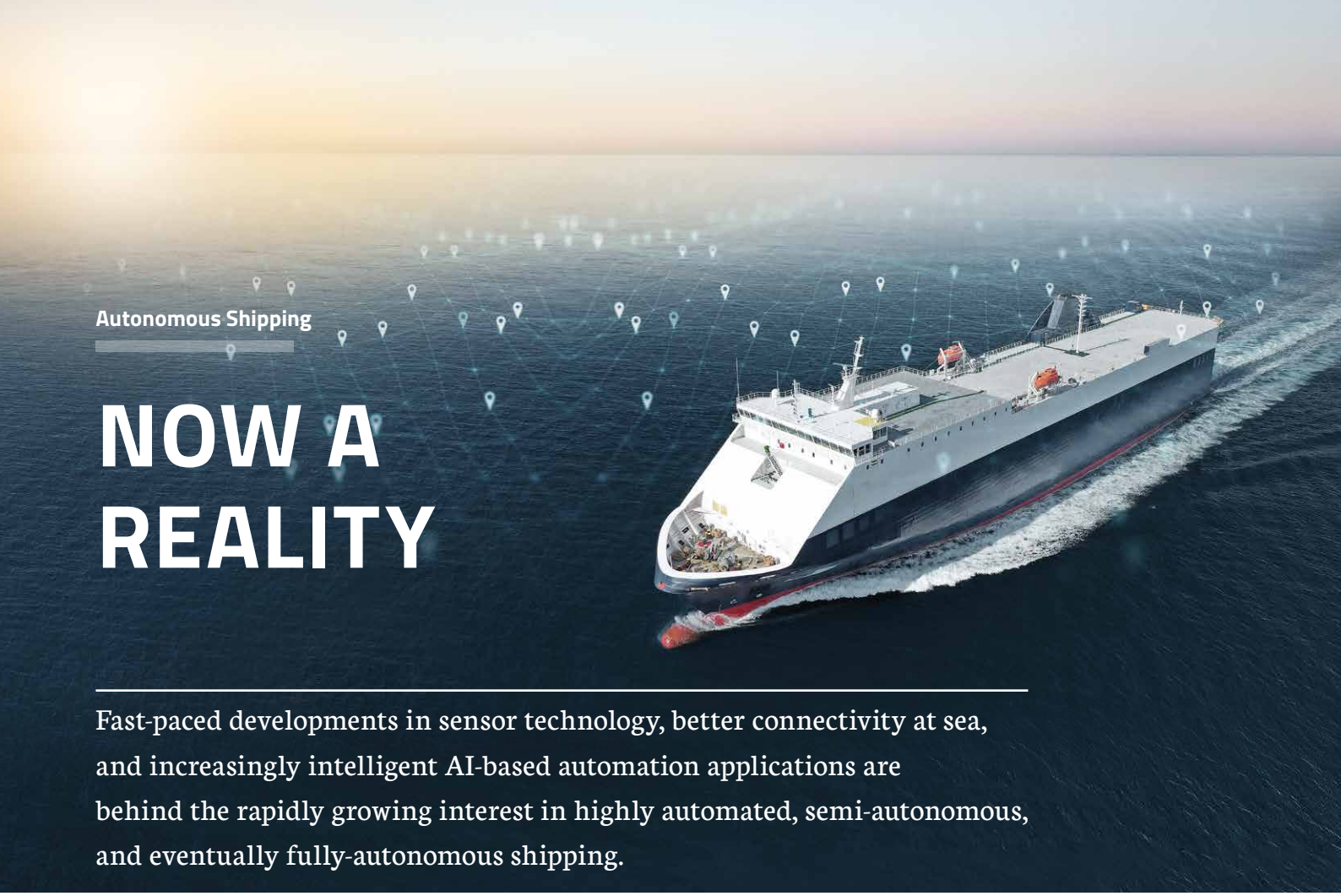

Autonomous Shipping

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Fast-paced developments in sensor technology, better connectivity at sea, and increasingly intelligent AI-based automation applications are behind the rapidly growing interest in highly automated, semi-autonomous, and eventually fully-autonomous shipping.

Automation concepts based on machine learning (ML) and artificial intelligence (AI) now facilitate a wide range of applications; some of which are already widespread in the maritime industry. Many ships now sail semi-autonomously with the help of assistance systems, for example, or are controlled remotely from the mainland with sophisticated automation technology.

Depending on the degree of automation, human intervention is only required either for selected tasks or for overall system monitoring.

Clear benefits

The benefits of these concepts for the maritime industry are obvious. Software-based ship intelligence (AI) can reduce human error and prevent collisions and maritime accidents. In addition, crew and skippers have more time to focus on other tasks. Optimized navigation routes reduce fuel consumption, reducing costs and protecting the environment. AI-based predictive maintenance means that repairs are caried out in good time, reducing downtime to a minimum.

Sophisticated technology

Semi-autonomous, remote-controlled or autonomous shipping, however, requires the successful combination of multiple components. There are sensors to monitor the ship's condition and surroundings, for instance, and the GPS navigation to determine the ship's exact location at all times. Further key components are the highly complex control algorithms that constantly make decisions based on available data, as well as a visualization system to convey all relevant information to crew both on board and on the land-based virtual bridge. A fail-safe connection between the onboard systems and those onshore is also critical, as well as the real-time exchange of data between systems from a wide range of manufacturers and platforms. The combination of Bachmann's robust and secure controller with Connext® software from Real-Time Innovations (RTI), leading Californian autonomous systems manufacturer, provides the prerequisite for a flexible and fail-safe automation platform for the networking of distributed systems. RTI software supports Data Distribution Service (DDS), an open standard for message exchange with high data connectivity and scalable architecture for real-time applications. Thanks to DDS, all controllers communicate directly with one other in real time. The constant availability of up-to-date information forms the basis of reliable, autonomously-controlled operations.

Human-machine communication

Despite all this technology, autonomous shipping still requires people. Unfortunately, many automation concepts are still not designed to actively involve people in processes. For example, some can only be switched on or off, while others run in the

background as assistance systems without the captain's awareness. But it is important for crew to understand what a machine is doing and why: This is the only way to ensure that those on deck, or on shore, can effectively monitor ship systems and respond appropriately if required. In addition, certain operations must still be mastered, despite automation, to avoid the loss of process knowledge. Although certain maneuvers can be performed independently by assistance systems, for example, the captain must be able to intervene or take over control at any time. Regular crew training is therefore essential, even as shipping becomes autonomous.

Feel the ship

Haptic feedback is an emerging trend in the maritime industry and a way to bring man and machine closer together. This technology enables systems and devices to communicate with the operator via touch impulses. Similar to modern cars, assistance systems provide haptic feedback – for steering or speed control, for example. The use of haptic feedback can also ensure that operators retain control of automated operations and, more importantly, can override them. Training becomes more efficient when simulators are equipped with haptic feedback. This intuitive learning method means a significant reduction in training time.

Exciting future

Highly automated and partially autonomous shipping is already a reality, and current technological developments in the maritime industry are promising. We look forward to the emerging opportunities and challenges over the coming years as we continue on the journey to fully-autonomous shipping.

HAPTIC FEEDBACK: FORCE FEEDBACK TECHNOLOGY WITH SMART SHIP

Dutch start-up Smart Ship uses the Bachmann controller to implement 'force feedback technologies' in the maritime industry. Custom-built components for ship control, such as throttle, tiller, azimuth and joystick, are connected to an algorithm that provides haptic feedback to ship operators during complex control operations through resistance and vibrations.

More than just vibration

Familiar to us all, the most basic form of haptic feedback is a vibrating cell phone. But smart-ship technology can do much more: "By using a control handle equipped with haptic feedback, we can transmit many different forces," explains founder Roy Kok. "In addition to vibration, resistance is also an important force. Variable resistance signals that you are approaching or moving away from a target, also allowing us to create virtual walls or 'no-go areas.'"

Conscious control

For remote ship operation and for supporting decision making in critical situations, it is especially important to quickly create awareness of the current situation. When ship AI alters the speed, for example, the captain feels a vibration at the throttle and can immediately check why this action was taken and whether it was correct. If not, he or she can intervene and override the system. Conversely, the system could apply resistance to the throttle, signaling that increasing speed is not recommended in current sea conditions or levels of visibility.

"Haptic feedback creates an awareness of what a machine is doing, even when visibility is poor or non-existent. And it is precisely this feature that will help us take the step toward fully autonomous shipping," says Roel Kuiper, research and development engineer at Dutch subsea specialist Seatools, and a Smart-Ship consultant.

Intuitive learning

Smart-Ship also equips training simulators with the same technology. According to Kok, humans respond instinctively to haptic stimuli – which is the reason for its huge potential. "From an early age, humans learn to interact with their environment by experiencing forces. Therefore, using haptic controls in education enables faster and more intuitive learning."

Guarantee security

Cybersecurity is one of the most important requirements in the development of autonomous shipping. The consequences of targeted disruptive access to a ship control system could be fatal. A well thought-out, multi-layered IT security concept, the use of hardware-based cryptographic methods, and a robust operating system are essential for providing sufficient protection against threats in networked automation. Moreover, end-to-end encryption for communications through SSL renders eavesdropping measures ineffective: All these functionalities are supported by Bachmann hardware, explains Kok. "In addition, Bachmann's controller is powerful enough to run the entire dynamic model in real time – speeding up development as well as testing for new systems, ensuring we continue to provide high quality," concludes Roy Kok.

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