

WHY REINVENT THE MARITIME WHEEL?



Commercial Maritime AI Technology Can Solve
Government Challenges



SEA MACHINES

INTRODUCTION

Government maritime organizations—from navies and coast guards to border security and environmental protection agencies—face exceptional challenges. Mission demands are evolving, the pace of missions is quickening, budgets are tight, societal expectations of personal welfare are changing, and a result is that shipboard personnel are overloaded and overworked.

New technologies, such as Artificial Intelligence (AI), can solve these problems. In the aviation and terrestrial sectors, AI-based systems—from autonomous high-altitude drone aircraft to self-driving vehicles—are transforming those industries. Now, AI is poised to reshape the maritime world.

But these technologies can also be expensive and time-consuming for the government to develop from scratch. Baring the question, why start from scratch when these systems already exist in the commercial world?





“The commercial sector should drive military development, not vice versa,”

said Rep. Rob Wittman during a March 2021 House Armed Services Committee hearing on Navy unmanned vehicles.

“...the Navy should be leveraging commercial technologies for further military application. Not only is the technology there, but remember, we are going to be in a resource-challenged environment. The way we prevail strategically is for us to do more with our dollar.”

The commercial sector brings tremendous strength to meeting government maritime requirements. Because of the pace of technological change in the business and consumer markets, companies are forced to rapidly develop and improve their products – or risk being driven out of business by their competitors or competing industries. While government-developed systems are often custom-built, highly specialized—and very expensive—the commercial sector is accustomed to designing straightforward and sensible technology that can be economically operated by a wide variety of customers. For private companies, factors such as user-friendliness, ease of maintenance, and painless upgrades are not luxuries, but the foundation of their business models.

NAVIES AND COMMERCIAL SHIPPERS FACE SIMILAR CHALLENGES

What is striking about the challenges faced by commercial and government operators is how similar they are. Whether it's the U.S. Navy or a commercial shipping carrier, or a tugboat or a guided-missile destroyer, all must navigate through crowded sea lanes and congested ports plied by undermanned vessels and overtired crews.



CONSIDER THESE COMMON CHALLENGES FACED BY GOVERNMENT AND COMMERCIAL SHIPS:



Obstacle avoidance.

The maritime world has suffered several prominent mishaps in recent years, including two U.S. Navy destroyers and one Royal Norwegian frigate that collided with commercial ships in 2017 and 2018 respectively. Such collisions are deadly, costly, and politically embarrassing.



Complying with

COLREGS. The Convention on the International Regulations for Preventing Collisions at Sea (COLREGS) was supposed to eliminate the chance of collisions. But understanding of the regulations—and compliance with them—is not always consistent.



Crew fatigue.

Fatigue was a major cause for the 2017 U.S. Navy destroyer collisions, and it is often at the root of commercial mishaps.



Situational awareness.

Correctly perceiving the surrounding environment, including obstacles and other ships, and how this will affect your ship – has become a problem for all mariners with line of sight and visibility challenges.



Sensory overload.

The multiplicity of sensors on today's vessels can overload bridge crews to the point that danger signs are overlooked. At the same time, the monotony of staring at empty ocean for long periods can drive watch officers to distraction.



Autonomous

vessels. That autonomous vessels will become more prevalent in the government and commercial sectors is a given. But challenges remain, notably how to ensure that robotic craft comply with COLREGS.

COMMERCIAL TECHNOLOGIES ALREADY EXIST FOR GOVERNMENT USERS

If government and commercial ships face similar challenges, then commercial technology to meet those challenges should also meet government needs. Three examples stand out:

ARTIFICIAL INTELLIGENCE

Artificial Intelligence has become the foundation of many advances in nautical technology. For example, commercial shippers are using AI to optimize fuel consumption and route planning. But commercial AI has also resulted in solutions for obstacle avoidance and vessel autonomy that could be extremely useful to government users. For example, AI can be programmed to follow COLREGS and other maritime rules.

Machine learning techniques enable AI to analyze vast amounts of sensor data and extract

patterns that enable the system to recognize other vessels, and either sound an alarm or automatically change course and speed.

Ironically, despite the sophistication of Artificial Intelligence, the advent of AI has actually simplified tasks for users. “Operator-in-the-loop” technology enables commercial vessels—such as tugboats—to function mostly autonomously, with operators only intervening as needed. Such capabilities would be immensely useful for government operators.



AUTONOMY

The commercial shipping industry has also been quick to appreciate the potential of autonomous vessels, which in turn has spawned a slew of autonomy products. For example, the SM series of maritime autonomy systems, from Sea Machines, allows existing manned vessels to be converted into autonomous or remote-commanded platforms. The SM series allows multiple levels of control, from the SM 200's remote-helm control by remote operators, to the SM 300's "intelligent vessel" that allows the vessel to function autonomously while under operator-in-the-loop command. These systems have already been deployed on commercial vessels, from small boats to larger cargo vessels. For example, the Captain Ben Moore, a 63-foot-long cargo ship launched in October 2020, is equipped with the SM 300 to enable remote operations from a land-based command station.

The SM300 allows vessels to be commanded from a mothership via IP radio, or from a shore station via 4G networks or satellite communications. The vessel can also motor autonomously from waypoint to waypoint, execute a survey or search-and-rescue pattern, or match the course and speed of the mothership. The system can also be set for timed tasks, such as loitering at a waypoint or activating a payload.



Autonomous vehicles are becoming a fact of life, most notably Google's self-driving car. Government has also begun to embrace autonomous ships.

The most contentious issue with autonomous vessels is whether they can safely operate while under autonomous control. The SM300 features electronic collision alerts and an active avoidance system designed to meet COLREGS. The technology controls the ship to automatically avoid targets—or alert remote operators—if data from Electronic Navigation Charts (ENC), Automatic Identification System (AIS), radar and sonar indicates a potential hazard.

Broad acceptance of autonomous vessels will likely hinge on performance validation over time, along with an appreciation of the "new normal" resulting relationship between the human operator and the autonomous system. This relationship involves shared control where the autonomous system

controls a vessel over 99% of a voyage with human oversight and human intervention only as needed, allowing operators to override the autonomy system and take over control. The SM300 allows the operator to intervene at any moment via the command GUI, changing the missions “on the fly”. The SM300 also enables the operator to take control via a joystick-based controller. Both options include the ability to monitor and manually adjust the propulsion and steering systems. The operator can also receive data from the vessel’s sensors — including radar and optical imagery — displayed on a laptop or big-screen monitor.

COMPUTER VISION

Another promising commercial technology is computer vision, found in some advanced autonomy systems coming to the market, such as the Sea Machines SM400. Computer vision is an AI-based technology that analyzes visual imagery from optical sensors. This allows the AI to identify and track ships and other potential obstacles and adjust speed and heading to maintain a safe distance. While the technology can be used by autonomous craft, it is particularly useful for assisting watch officers on manned vessels to maintain comprehensive situational awareness.

For example, fully complying with COLREGS requires a ship’s crew to classify the type of vessels in their vicinity, as well as understand their current movements and activities. While sensors such as radar are vital for navigation, only visual observation provides certain crucial data, including perception of color, texture, and context. By combining imagery from optical sensors with the ability of AI to constantly analyze visual data, without the possibility of fatigue or distraction, computer vision vastly enhances situational awareness.

For military and law enforcement customers, computer vision has the advantage of being a passive sensor system. Because it relies on optical imagery rather than emitting signals like radar does, vessels don’t risk disclosing their position during sensitive operations.

Computer vision can be part of a ship’s array of sensors, adding additional sensor redundancy to radar and AIS. As computer vision technology matures, it can replace radar and AIS in some situations. In many ways, computer vision resembles human vision.

It essentially replicates the process by which the humans visually perceive their environment, but with sensors and algorithms replacing the retina and cortex. For humans, visual

perception comes naturally and without conscious thought, a process honed by millions of years of evolution, and then refined from birth by continual experiences.

However, this is neither a natural nor easy process for computers. Computerized image recognition has been around since the 1960s, which enabled the development of technology such as optical scanners. But while a vast improvement over the drudgery of humans having to match a face or a license plate with a filing cabinet full of photographs, automation had severe limitations. Humans had to laboriously tag photos and code the software to recognize them.

In contrast, computer vision is based on machine learning, which uses algorithms to replicate some aspects of the human brain. It utilizes neural networks of algorithms that analyze data in a roughly similar way as the human brain does. By feeding in vast numbers of photos and videos and associated metadata the AI learns to match patterns of physical characteristics and behaviors, and thus identify objects.

For example, the computer vision used in the upcoming Sea Machines SM400 enhanced situational awareness system is based on visual data compiled from three years of vessel operations in many waterways. As more imagery becomes

available from testing and operational use at sea, the data set utilized by the AI will continue to expand over time, thus making computer vision like the SM400 more capable of detecting and responding to obstacles.

This is good news for bridge crews responsible for the fleets that include the largest machines built by mankind, for whom computer vision can be a lifesaver. Computer vision enhances situational awareness and alerts crews to potential hazards that may be manually overlooked or misunderstood.

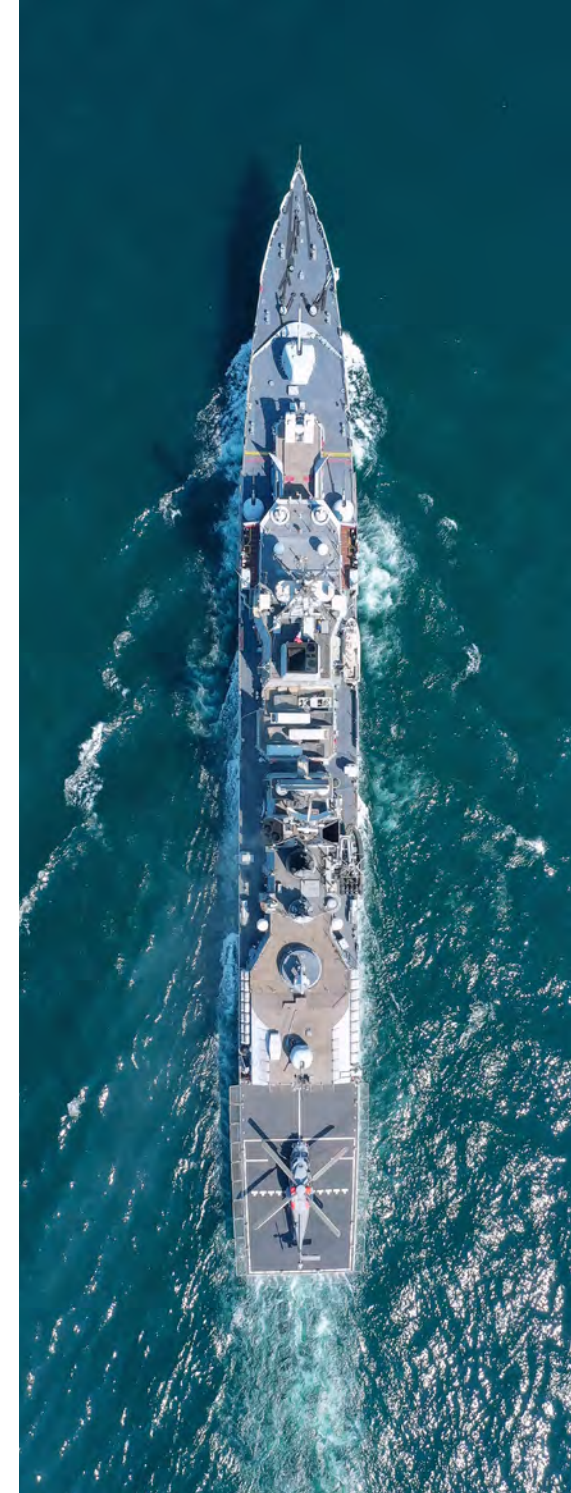


CONCLUSION

Today, AI-based autonomous navigation systems feature dynamic route planning, coordination of multiple vessels, program COLREGs, and maritime best practices into AI, and are adept at avoiding potential mishaps. Perhaps the most significant benefit of these systems is that they remove situational awareness deficiencies caused by vessel's geometry, conventional sensors limitations, and innate human error.

Technology designed for the commercial market can already function under a wide range of conditions, including rough seas, intermittent maintenance, and missions that may place personnel in harm's way. Equally important, commercial technology offers governments the opportunity to be part of a continual process of improvement and upgrade. The commercial market is not static: business competition will ensure that governments take advantage of the latest advancements.

Regardless of flag or function or government or civilian ownership, vessels and their crews are expected to perform operations reliably and safely. **And ultimately, full autonomy capabilities will become a standard feature on ships as radar, GPS, and AIS have become standard today.** So if the commercial sector has already developed solutions, then why should the government pay to reinvent the maritime wheel?





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