Findings: Research and Development on Unmanned Surface Vehicles

April 7, 2022

Fiscal Year 2021 Report to Congress

Homeland Security

United States Coast Guard

Foreword

April 7, 2022

I am pleased to present the following report, "Findings: Research and Development on Unmanned Surface Vehicles," which has been prepared by the U.S. Coast Guard.

House Report 116-458 accompanying the Fiscal Year 2021 Department of Homeland Security Appropriations Act (P.L. 116-260) directs the Coast Guard to provide a report on the findings of research and development activities related to unmanned surface vehicles as outlined in the July 19, 2021, report to Congress: "Research and Development on Unmanned Surface Vehicles."

Pursuant to congressional requirements, this report is being provided to the following Members of Congress:

The Honorable Lucille Roybal-Allard
Chairwoman, House Appropriations Subcommittee on Homeland Security

The Honorable Chuck Fleischmann
Ranking Member, House Appropriations Subcommittee on Homeland Security

The Honorable Chris Murphy
Chair, Senate Appropriations Subcommittee on Homeland Security

The Honorable Shelley Moore Capito
Ranking Member, Senate Appropriations Subcommittee on Homeland Security

I am happy to answer any further questions that you may have, or your staff may contact my Senate Liaison Office at (202) 224-2913 or House Liaison Office at (202) 225-4775.

Sincerely,

Karl L. Schultz
Admiral, U.S. Coast Guard
Commandant

Findings: Research and Development on Unmanned Surface Vehicles

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I. Legislative Language

This document responds to the direction set forth in House Report 116-458 accompanying the Fiscal Year 2021 Department of Homeland Security (DHS) Appropriations Act (P.L. 116-260).

House Report 116-458 states:

> Unmanned Surface Vehicles (USV).—The Committee directs the Coast Guard to report on the plans for research and development activities related to USVs not later than 90 days after the date of enactment of this Act, and of the subsequent findings when they are available. Such findings should include how data collected by these vehicles could augment current assets and support operational maritime awareness, surveillance and reconnaissance.

II. Report

The Coast Guard is researching new technologies, including autonomous systems, to improve maritime domain awareness (MDA). Increasing MDA can contribute positively to all 11 Coast Guard statutory missions, including: drug interdiction; migrant interdiction; port, waterways, and coastal security; marine environmental protection; living marine resources; and enforcement of laws and treaties. It is essential for the Coast Guard to achieve comprehensive MDA in maritime regions under U.S. jurisdiction, and to have the ability to communicate, integrate, and analyze information rapidly to facilitate effective and appropriate actions.

The USVs offer the potential to expand MDA by providing distributed low-cost intelligence, surveillance, and reconnaissance (ISR) platforms and to enhance the performance of crewed assets by expanding their ISR capabilities. Likewise, USVs could fill gaps where it is too risky to send people or when crewed assets are unavailable.

Unmanned Surface Vehicles

The USVs are a relatively new technology compared to unmanned aerial vehicles (UAV), which have been in use for nearly two decades. The Coast Guard, which is evaluating the ability of USVs to provide persistent ISR capabilities, has commenced two projects to evaluate their capabilities and potential for integration into mission execution.

The first is an MDA pilot to determine the efficacy of using low-cost, commercially available technology solutions in combination with existing platforms. This project began in 2018 and culminated in a month-long technology demonstration in the fall of 2020. A final report was issued in April 2021 and a summary of the findings are described in this report.

The second is the Maritime Unmanned Systems Technology project managed by DHS's Science and Technology Directorate in partnership with the Coast Guard. This multi-year project began in 2019 to evaluate the use of USVs to provide persistent and cost-effective ISR capability for law enforcement, security, and pollution response missions in support of broad MDA objectives. It is anticipated that this project will be completed in late 2023.

These two projects are the first extensive evaluations of USV technologies by the Coast Guard. The Coast Guard plans to continue research and development efforts of USV technologies to understand their capabilities and effectiveness for Coast Guard missions and to identify the attributes of a successful system. For example, the Coast Guard must determine if a large number of small USVs with limited sensors, speed, and maneuverability are more desirable than a smaller number of medium-to-large USVs with better sensors, speed, and maneuverability. USV performance also must be compared with the effectiveness of UAVs, space-based systems, and other technologies. The Coast Guard's continued research into USV technologies will help to provide these answers, and will support the development of requirements and the eventual acquisition and fielding of appropriate systems to enhance MDA and mission performance.

Findings

In 2018, Congress directed the Coast Guard to perform a pilot study and assessment of low-cost commercially available technologies to enhance MDA in remote Pacific regions with a focus on illegal, unreported, and unregulated fishing. The Coast Guard's Research and Development Center (RDC) identified Saildrone and Spatial Integrated Systems (SIS) to participate in a 30-day technology demonstration. In addition, an autonomous vessel owned and operated by RDC participated in the technology demonstration. RDC conducted the demonstration in the waters off Honolulu, Hawaii, from October 7 to November 5, 2020, to generate data and to examine the operational utility of a USV system for improving MDA.

System Descriptions

Saildrone performed the 30-day demonstration with six "Generation 6" USVs, which are 23-foot fiberglass sailing vessels with a 15-foot fiberglass airfoil for a sail. These USVs utilized wind for propulsion and utilized solar arrays to power onboard electronics. Sensors included a daytime-only camera system and an Automatic Identification System (AIS) receiver.

SIS employed a Watcher USV, which was developed from a 21-foot Coast Guard Cutter Boat - Large platform. An inboard diesel engine with auxiliary fuel tanks powered the USV, while onboard solar arrays augmented the power supply for the onboard electronics when the diesel engine was not running. While the vessel is equipped with autonomous controls, it is also capable of hosting a two-person crew for manual operation if necessary or desired. Sensors included a daytime/nighttime camera system, radar, and AIS.

The RDC's USV was based on a 29-foot Coast Guard Response Boat – Small II platform and has the ability to operate manned, remotely, or autonomously. This USV was included as a support vessel, as well as to demonstrate remote control and autonomous operation. As part of the demonstration, RDC set up an unclassified USV Data Fusion Center at its main facility in New London, Connecticut, to evaluate whether data transmitted by the USVs were actionable for Coast Guard operations.

Performance

Overall, the demonstration showed that commercially available USVs are capable of performing some level of daytime MDA missions for 30-day endurance missions. The participating systems were able to detect targets visually in excess of the threshold requirement of one nautical mile, typically detecting targets of 40-60 feet in length at a distance of 3-5 nautical miles or more. Each system demonstrated the ability for remote operations from operation centers several thousands of miles away in California, Virginia, and Connecticut. The systems demonstrated some level of autonomy in navigating and detecting/reporting targets.

Limitations

This technology-focused demonstration was daytime-only MDA; therefore, a true understanding of nighttime capability is not known. Given that the USVs had only one or two sensors of limited capability, there were deficiencies in the USVs' overall performance. One of the systems could provide only bearing to a target and an estimated range, but not an exact location. The systems could notify operators only of target presence (detection) but had no ability to classify or identify targets without assistance by operation center personnel. Systems also had a tendency to report false positives by detecting "targets" onshore, or would identify a single target over time as multiple targets. These limitations and the latency of the data transmitted created difficulty in gaining actionable intelligence and true MDA. Additional autonomy through the employment of artificial intelligence and machine learning is needed to classify targets properly and to provide a more coherent picture of activity in a given operational area. The technology demonstration also highlighted the eventual need for improved organic Coast Guard networking capability to process, move, and store sensor data to realize fully the effectiveness of unmanned systems.

Current regulations also present a limitation to the wide application of USVs for mission support or execution. Vessels registered in countries signatory to the Convention on the International Regulations for Preventing Collisions at Sea, 1972, are required to meet certain prescriptive requirements including, but not limited to, Rule 5, which requires all vessels to maintain a proper lookout by sight and hearing. Prevailing interpretation of this rule requires the use of a human to maintain the lookout at all times. This legal requirement historically has placed a barrier on reducing the watch standing requirements onboard ships and continues to be an impediment to full autonomous operation.

III. Conclusion

The technology demonstration showed that the tested USVs can collect copious amounts of data, transmit some of it in real time, and provide some level of MDA; however, further development is necessary before the full potential of autonomous USVs can be realized in Coast Guard operations. This was the first in-depth evaluation of USVs by the Coast Guard and follow-on studies that build on lessons learned are necessary to identify and refine vehicle capabilities, sensor suites, and data management to align better with Coast Guard mission needs. Furthermore, follow-on studies will help to inform where and in what missions USVs can be an effective force multiplier.

Appendix: Abbreviations

Abbreviation	Definition
AIS	Automatic Identification System
DHS	Department of Homeland Security
ISR	Intelligence, Surveillance, and Reconnaissance
MDA	Maritime Domain Awareness
RDC	Research and Development Center
SIS	Spatial Integrated Systems
UAV	Unmanned Aerial Vehicle
USV	Unmanned Surface Vehicle