Students Build Replicas of Unmanned Smuggling Boats to Help Coast Guard Find Them

Unique Camera System Improves Probability of Detection

By Edward Lundquist

A UNIQUE STUDENT PROJECT is helping the Coast Guard find small and hard to detect unmanned autonomous surface vessels (UASVs) that can be used to transport drugs into the U.S.

Several UASVs have been recovered attempting to transit from around the maritime border with Mexico and into California. The boats are can carry about 90 lbs. of cargo, which could be illegal narcotics, explosives or other contraband

According to Coast Guard Sector San Diego officials, four of the UASVs were seized by federal law enforcement authorities in Southern California. The first was found in March 2018, another in December 2020, and two more in February and March of 2021, suggesting a high likelihood that there are many more that have gone undetected.

To learn how these boats might be best detected by sensors, the Coast Guard engaged the National Security Innovation Network (NSIN), which collaborates with major universities and the venture community to develop solutions that drive national security innovation. With Coast Guard Sector San Diego as the project sponsor, NSIN capstone students at San Diego State University and Rice University in Houston, Texas, have been prototyping boats this semester.

The vessels are 3 to 4 feet long and have a freeboard of three to seven inches. They are autonomously navigated and can travel for about 66 nautical miles at a speed of about 2.5 kts.

Their above water profile is minimal, which makes these devices obscure to existing maritime domain awareness tools and detection capabilities. Not only are they capable of reaching uninhabited shores with illegal narcotics but they could also be capable of penetrating defense layers surrounding coastal- and harbor-based high value targets—such as military bases, power plants, or critical infrastructure--with explosives.

The purpose of this particular NSIN project is to improve coastal surveillance, detection, and interdiction capabilities to threats posed by this evolving threat. The students were tasked with designing and testing a UASV with similar characteristics to ones previously detected, and to test and demonstrate detection using an existing surveillance tool.

The WAV Surveillance System can generate a 90 degree field of view high-resolution image at 1 Hz that is then processed for detection and tracking.

NSIN has memorandums of understanding with universities across the country—including SDSU and Rice--to build relationships between the DoD and the communities. Through these partnerships, new, diverse, ideas and talent apply their skill sets to real-world national security problems.

The boats were "reverse engineered" by students from San Diego State University and Rice University, based on the actual boats that were captured, and built using the same materials and production process. The Rice University boat was used in demonstrations in Galveston, Texas, March 29-30, to see how a special high-resolution/wide angle camera surveillance system, called a WAV Surveillance System, could be used to detect the boat in realistic conditions.

WAV is a long-range video surveillance solution for homeland security applications and other situations that require persistent visual-domain awareness of very wide areas. It was designed by and developed by Innovative Signal Analysis Inc., of Richardson, Texas, and has both commercial and

The U.S. Coast Guard conducted a demonstration with a prototype unmanned autonomous surface vessel to sea to better understand how to detect small UASVs being used for illegal trafficking across the maritime border with Mexico."

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military applications. WAV is uniquely able to function as both a wide-angle and zoom camera at the same time, and is currently deployed in San Diego Harbor and other ports and harbors in the U.S. WAV's imagery was the tool that led to the eventual discovery of the UASVs.

"The WAV surveillance system can detect low probability of intercept (LPI) targets because it can survey a 90-degrees field of view at high resolution with a higher refresh rate than standard point-to-zoom cameras," said Jonathan Ray of Innovative Signal Analysis (ISA) of Richardson, Texas, the company that makes WAV. "We take advantage of these components in our algorithms to build a history of detects of the object to improve location accuracy and object detection confidence."

"We installed a GPS tracking unit on the micro-vessel so we could get truth data on our system's positioning and tracking," said Rachel Rivera, a solutions architect with ISA. "We recorded all of the data, and used the camera archive to replay the data and improve our detection and tracking algorithms. This will enable us to make a more specific detection analysis for refined tracking."

"The Rice student team designed and constructed a model that can be used to test existing systems leading to enhanced capabilities and also providing a roadmap for others to replicate similar platforms to routinely test their own system," said Fritz Kuebler, Rice University's Office of Research NSIN program director.

"This project has been underway for about two months and has involved extensive research, design and testing by the student team with regular interaction from the project sponsor," said Kuebler.

"Coast Guard Sector Houston-Galveston has been an ardent supporter of this project and provided assets to assist with the testing including deploying and recovering the UASV on the testing days, and coordinated participation with local maritime security stakeholders," said Kuebler. "Additionally, there are multiple local, state and federal agencies interested in this project. The Coast Guard has networked with surrounding maritime security stakeholders to bring visibility to this threat and how it may impact the Ports of Houston, Galveston and Texas City and their commercial partners located on and around the Ports' infrastructure."

"This project highlights the value of bright, dedicated STEM students working with national security experts to make a real difference," Kuebler. "It also serves as a proof of concept and example for how creative thinking and new methodologies advances broader U.S. strategic objectives regarding maritime security and the value of this critical infrastructure." NEJ