MSC Summer Research Institute (SRI)
Student Research Projects
June 3 – July 26, 2019

- **Wave Adaptive Modular Vessel (WAMV)- Unmanned Surface Vehicle (USV) WAMV / USV Simulator**: The student contributors to this project will leverage the newly released Virtual RobotX (VRX) simulation environment to simulate the operation of a Wave Adaptive Modular Vessel (WAM-V) unmanned surface vehicle as it navigates complex and obstacle-filled marine environments. The autonomous WAM-V must patrol and inspect its surroundings, while maneuvering and occasionally docking in a collision-free and time-efficient manner. The team will use the simulator to prototype autonomous navigation capabilities that will eventually be deployed on Stevens' physical WAM-V platform.

- **Enhanced Perception and Navigation for the BlueROV Underwater Robot:** Stevens' Robust Field Autonomy Lab has developed a customized BlueROV underwater robot capable of accurate subsea localization and mapping in cluttered marine environments, with the aid of multibeam imaging sonar and other acoustic sensors. This summer, the BlueROV will be used to autonomously explore a harbor environment. Given designated boundaries, the robot must repeatedly decide where to collect each sensor view, in order to produce the most accurate and complete map possible of its surrounding subsea environment. A combination of indoor tank testing and outdoor harbor testing will be used to demonstrate this capability.

- **Automatic Identification System (AIS) Vessel Anomaly Detection:** The Automatic Identification System (AIS) is a system used on a global basis to manage shipping traffic and to enhance safety at sea. The AIS system collects large amounts of ship voyage data. Irregularities in AIS data might reveal suspicious activity. The team will develop and use automated algorithms to detect vessel irregularities/anomalies from regular traffic patterns. This analysis will be in support of USCG and Customs and Border Protection initiatives.

- **UAS Buoy System – Prototype development:** The team will build upon the design plans created during the 2018 Summer Research Institute, to include technical drawings for a UAS deployable buoy system. The team's work will include a drone release mechanism and customized software for deployment. The team will interact with academic researchers and representatives from industry to build out the UAS buoy system design.

- **Risk Management Dashboard:** The USCG maintains a large data base of information pertaining to maritime safety, security, and law enforcement incidents. These incidents include vessel collisions or near collisions, pollution, breach of security and so forth. The data base is referred to as the MISLE (Marine Information for Safety and Law Enforcement) system. Information is entered into this system by operations officers on a nationwide

basis. Although this information may provide valuable insights into risk areas and subsequent risk management initiatives on a national level, it is not analyzed to permit effective risk management on a port specific operational level. In this task, students will conduct research to mine open source USCG incident data to enable more effective management of risk. Outcomes from the project will include a prototype for a risk management dashboard.

- **Red Team/Blue Team Exercises:** Many situations in life involve adversarial situations. Studying such situations involves anticipating the way participants will act. One way to do this is through games; games set up a set of rules, then allow for tactics and strategy within those rules. From a research perspective, they make it possible to collect data that may be generalizable to other situations. For example, the military engage in war games for this reason. This project takes a particular adversarial situation, in which a red team seeks to smuggle contraband goods and the blue team seeks to catch the smugglers. The goal of the project is to gain insight into how to better defend borders in the face of creative adversaries. One part of the research will be designing a game that captures the essence of the situation. A second part will involve playing the game many times in order to generate data. A third part will be analyzing the data. This project has room for those who are interested in the design of board games, simulations, and computer games, as well as those interested in policy and law enforcement.

SRI Student Team Project Deliverables:
MSC Summer Research Institute student research projects will result in a report, research poster and a final presentation for MSC research investigators and DHS stakeholders.