Topic: OSD12-HS3

Charles River Analytics Inc.

Topside Optical Processing for Global Unmanned Navy (TOPGUN)

TOPGUN detects and classifies ships in color video using state-of-the-art deep learning techniques, which can be used by any manned/unmanned vessel to avoid collisions. TOPGUN detection is reliable even in cluttered scenes, and detected ships are classified into categories, including cargo vessel, sailboat, and military ship, to support safe navigation for unmanned vessels and increased situation awareness for manned vessels. We have demonstrated TOPGUN live on the water using commercial cameras and processing hardware. We are combining TOPGUN with whale and obstacle detection on a smart camera with an embedded processor to create a maritime smart camera that provides situation awareness and collision avoidance for military and commercial vessels. Ideal partners are building unmanned surface vessels, smart cameras, or ship surveillance and security systems.

Technology Category Alignment:

EO/IR Components for sensing, transmission and communication
Machine Perception, Reasoning and Intelligence
Unmanned Ground and Sea Vehicles
Sensors
Electro-Optical/Infrared (EO/IR)

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SYSCOM: ONR
Contract: N68335-17-C-0154

Corporate Brochure: https://navystp.com/vtm/open_file?type=brochure&id=N68335-17-C-0154

Tech Talk: https://atsi.adobeconnect.com/penml0ow7epg/

Department of the Navy SBIR/STTR Transition Program

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Topside Optical Processing for Global Unmanned Navy (TOPGUN)

Charles River Analytics Inc.

WHO

SYSCOM: ONR

Sponsoring Program: Not specified

Transition Target: Any unmanned vessel that needs the ability to avoid collisions with manned vessels by following the International Regulations for Preventing Collisions at Sea (COLREGS)

TPOC:
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Other transition opportunities: Navy PMS 406 programs

Notes: This project builds on two previous efforts: 1) our Phase I Taxiing Operations via Gesture Understanding (TOPGUN-I) SBIR, wherein we developed a data-driven Object Detection Framework (ODF); and 2) our CROWSNEST effort, wherein we used the ODF for fast and reliable ship detection and convolutional neural networks for robustly classifying ships into the appropriate COLREGS classes based on their appearance. The TOPGUN program focuses on collecting additional training data, refining existing algorithms, hardening system software, and supporting testing in representative environments.

WHAT

Operational Need and Improvement: When operating at sea, crews expect other ships to react according to the International Regulations for Preventing Collisions at Sea (COLREGS). In order to navigate safely and carry out their operations, unmanned vessels must adhere to these same rules. Legal precedence and regulation also indicate that unmanned vessels must adhere to COLREGS and assume the same responsibilities as vessels under human command. Therefore, before unmanned vessels can be fully leveraged, they require a robust, reliable COLREGS-compliant navigation solution. Two of the main challenges for autonomous COLREGS compliance are reliably detecting other vessels, and classifying them according to their COLREGS class. Because certain classes of vessel (e.g., sailboats and fishing boats) have the "right of way" over others, determining the COLREGS class based on vessel appearance is especially critical for avoiding collisions. TOPGUN provides the ship detection and classification capabilities needed to support COLREGS compliance.

Specifications Required: Perform visual detection and classification of surface contacts at ranges sufficient to enable appropriate navigation responses (e.g., turning to port or starboard, slowing down, or speeding up).

Technology Developed: TOPGUN uses state-of-the-art deep neural network techniques to learn the appearance of a variety of ship classes from training data. The software is optimized to run on embedded processors, enabling real-time situation awareness on smart cameras and low-power hardware. We are combining TOPGUN ship detection and classification with whale and obstacle detection on an embedded GPU to create a maritime smart camera that provides situation awareness and collision avoidance for military and commercial vessels.

Warfighter Value: TOPGUN's surface situation awareness enables COLREGS-compliant unmanned surface vessel (USV) operations. USVs will be a critical force multiplier for maritime operations, and they must navigate safely and autonomously to realize their full benefit to the Warfighter. TOPGUN enables safe navigation for USV by detecting and classifying ships in real-time with relatively low-power processors. Beyond USV applications, TOPGUN can also alleviate the cognitive burden on watchstanders on manned vessels by providing a lookout that is not subject to human fatigue and alerts the crew to contacts and potential collisions.

WHEN

Contract Number: N68335-17-C-0154 **Ending on:** February 29, 2020

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Demonstrate ship detection	N/A	>95% probability of detection on thousands of images	5	4th QTR FY17
Demonstrate ship classification	N/A	>80% probability of correct classification on thousands of images	5	4th QTR FY18
Demonstrate live detection and classification	Low	>15 frames per second	6	4th QTR FY19
Demonstrate detection and classification on smart camera	Med	>15 frames per second onboard smart camera	7	1st QTR FY20

HOW

Projected Business Model: There are two approaches to commercializing TOPGUN, (1) the detection and classification software can be licensed to other commercial entities that'll use it directly or incorporate it as added functionality to their commercial products or (2) this new technology can be used as a key building block in a novel maritime smart camera product, which we are currently developing. We are exploring three approaches to maritime smart camera development, (1) we can purchase commercial smart camera hardware platforms, install our software on them, and resell the resulting maritime smart camera for a profit, (2) we can team with companies producing commercial smart cameras by licensing our software to them and taking a per-unit fee, and (3) we can develop our own smart camera hardware and software to meet the specific needs of the maritime domain.

Company Objectives: Defense applications of this technology include safe, COLREGS-compliant navigation of unmanned surface vessels and enhanced situation awareness for crews of manned vessels. At FST, we are looking for partners who are building unmanned surface vessels, developing smart camera products, or putting cameras on manned vessels and need situation awareness and ship security solutions. Charles River Analytics conducts leading-edge AI, robotics, and human-machine interface R&D and leverages that R&D to create tailored, customer-focused solutions, so we are always interested in meeting potential partners and customers with interests and needs in these areas.

Potential Commercial Applications: The commercial market needs more affordable smart cameras that can warn of possible collisions in standalone mode or integrated with autopilots to provide true autonomous collision avoidance. Big name maritime camera makers offer high-end systems that provide alerts when non-water objects are detected but customers must make further purchases, bundling cameras with multi-function navigation displays, which increases system complexity and potential points of failure, to take advantage of these capabilities. There is a gap in the market for a standalone, lower-price smart camera with "plug and play" usability, and there are companies currently making more affordable maritime cameras that lack domain-specific smart processing; we can address that with TOPGUN.

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