Department of the Navy SBIR/STTR Transition Program

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NAVSEA #2022-0355

Topic # N191-016
Clustering and Association for Active Sonar Tracking and Classification
ARiA

WHO

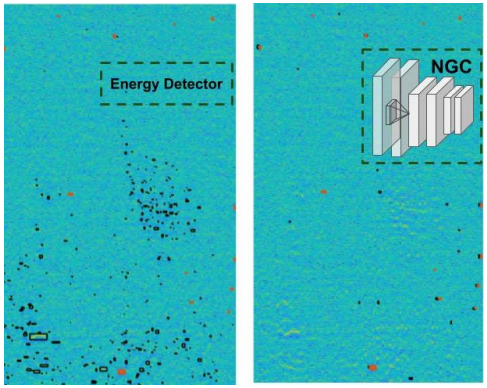
SYSCOM: NAVSEA

Sponsoring Program: NAVSEA PEO IWS 5.0

Transition Target: AN/SQQ89A(V)15 Integrated Undersea Warfare (USW) Combat System Pulsed Active Sonar (PAS) functional segment (PASFS) Echo Tracker Classifier (ETC)

TPOC: (401) 832-2752

Other Transition Opportunities: Sonar signal processing for: Arleigh Burke (DDG) class destroyers, and Ticonderoga (CG) class cruisers, t the AN/SQQ-89A(V)15; Oliver Hazard Perry class frigate (FFG) fitted with the AN/SQQ-89F; Littoral Combat Ship (LCS ASW Mission Package (MP); Coherent Multistatic Acoustic Processor (CMAP) on the P-8A Poseidon; and the Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Integrated Undersea Surveillance Systems (IUSS) Integrated Common Processor (ICP).



Notes: ARiA combines real-world experience with knowledge from subject-matter experts in acoustic signal processing and artificial intelligence to develop the Next General Clusterer (NGC), a robust, intelligent, low-latency system for clutter mitigation. The left subplot depicts clusters of contacts formed by energy detectors (the current state of practice), while the right shows clusters generated by NGC. Red boxes indicate true targets, and black boxes indicate clutter detections. NGC is able to consider contextual and structural information in acoustic data over an extended spatial region to achieve better clutter discrimination. Designed with flexibility in mind, NGC is highly modular, and capable of platform integration along many paths, including in parallel with existing components. This flexibility significantly mitigates integration risk by minimizing upstream or downstream changes in the current signal processing chain.

WHAT

Operational Need and Improvement: A crucial role of the active-sonar component of Anti-Submarine Warfare (ASW) is detecting and classifying submarines amid environmental clutter. Current methods apply a sequence of algorithms designed to detect, localize, and classify subsurface vessels; one of which consists of forming and classifying clusters of acoustic energy. An opportunity exists for development of detection and classification technologies, which leverage contextual and spatial information, to mitigate challenging environmental clutter. ARiA, leveraging extensive knowledge of deep learning, has developed a system which is able to reduce instances of single targets being split into multiple clusters and/or tracks; clutter tracks incorrectly classified as targets; and true tracks that are identified late or missed altogether due to corruption by clutter.

Specifications Required: The goal for improvements to the submarine detection segment of the active sonar signal and information processing chain is to reduce the false track rate by 50% while maintaining probability of true alert, thereby reducing operator workload and staffing requirements. Additionally, predictions made by this network cannot introduce any significant latency when compared to the baseline system. These improvements must be confirmed on real data, and require testing on a diverse collection of datasets, each containing active-sonar signals acquired in the field by the AN/SQQ-89.

Technology Developed: NGC is a convolutional-neural-network (CNN) based detector/classifier, designed using state-of-the-art computer-vision techniques. The network is best described in terms of two key components: the backbone feature extractor and the detection/classification head, each custom designed for subsurface object detection. The feature extractor, using multiple interconnected layers, is configured specifically to learn contextual features for target classification, as well as spatially compact features for target detection. The detector/classifier head divides the input image into a grid, and synthesizes these features to predict object location and shape, the probability that the object is a target, and, optionally, the type of target. Advantages of this network design include robustness to input size, built-in scalability, and low prediction time. One challenge for deep-learning development is overfitting to training data, which is why ARiA has also developed a robust test suite that examines detection and classification performance with partitioned data over many metrics, minimizing the possibility of delivering a model that performs well in the lab, but poorly in the field.

Warfighter Value: The primary goal of NGC is to remove spurious information presented to the active sonar operator, thus reducing overall operator workload. NGC reduces the number of clutter clusters consumed by downstream tracking algorithms, and thus the operator will have fewer irrelevant tracks to interrogate. NGC is also designed to operate within the current detection/classification regime, mitigating the need for additional operator training.

WHEN

Contract Number: N68335-21-C-0095 **Ending on:** Apr 13, 2022

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Develop Initial NGC Prototype	Low	Demonstrated initial detection and classification performance, clutter reduction	4	2nd QTR FY21
Mature prototype and demonstrate on operational data (Step 1 Evaluation)	Low	Demonstrated performance on operational data relative to existing SQQ-89 baseline.	5	1st QTR FY23
Submit algorithms for independent Step 2 evaluation	Low	Confirmed detection and classification performance on operational data	6	3rd QTR FY23

HOW

Projected Business Model: ARiA plans to retain the SBIR data rights for the developed signal processing algorithms, with Navy and large primes to integrate algorithms into tactical systems for fleet use. ARiA's algorithms are targets for initial transition into the AN/SQQ-89A(V)15 USW Combat System in ACB25 with transition to related tactical systems to follow.

Company Objectives: ARiA's objective is to further investigate and develop Navy and DoD applications of deep-learning algorithms for clutter mitigation. ARiA intends to integrate these algorithms into the AN/SQQ-89A(V)15 USW Combat System in ACB25 as the initial application of this technology to tactical sonar systems. ARiA is looking for programs and prime partners working with other tactical sensor systems that can benefit from improved detection and clutter mitigation.

Potential Commercial Applications: The algorithms that ARiA has developed are applicable to a wide range of sensing modalities including radar and sonar. Algorithms may be adapted most directly to commercial mid-frequency sonars, e.g., single-beam and multiple-beam (swath) bathymetry, acoustic seafloor characterization, and commercial fish-finding sonars.

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