Topic: N172-108

Science Systems Solutions, Inc.

Fusion of Radar and Electro-Optical/Infrared (EO/IR) for Ship Classification and Identification

Radar, electronic support measures (ESM), a.k.a. anti-radiation homing (ARH), and electro-optical (EO)/imaging infrared (IIR)/laser detection and ranging (LIDAR) currently provide different sensor phenomenology that can lead to different salient feature manifestation that depends on operating conditions (e.g., acquisition geometry) and scene content type. Current technology approaches develop automatic target recognition (ATR) systems for a single sensor, each designed to exploit the salient features specific to each sensor type, which leads to suboptimal classification performance for each sensor type and not a higher confidence performance by combining independent sensor data into a single solution. The capability to combine the salient feature information from the different sensors to get improved target classification, and possibly identification, of the ships, is needed. We propose a two-prong machine learning approach that simultaneously uses two complementary techniques, deep learning convolutional neural network (CNN) and compressive manifold learning (CML), to exploit the automatic feature and regularities discovery of deep learning to fuse the multiple sensor data and the sparsity representation of the data in manifold learning to fuse the raw sensor data as represented by their highly compressed lower-dimensional manifolds. This two-prong approach combines with the baseline handcrafted features used to augment the features discovered by the deep learning CNN algorithm, will provide unprecedented robust ship classification and potentially identification performance. For operational utility, we will leverage industry commercial off the shelf (COTS) multi-core graphical processing units (GPUs) processors such as those already developed by NVIDIA and Intel specifically for deep learning implementations.

Technology Category Alignment:

Broadband/Multispectral Components and Systems
Cognitive/Adaptive Capabilities
Electro-Optical/Infrared (EO/IR)

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SYSCOM: NAVAIR
Contract: N68936-19-C-0024

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Department of the Navy SBIR/STTR Transition Program

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NAVAIR 2019-841

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Fusion of Radar and Electro-Optical/Infrared (EO/IR) for Ship Classification and Identification

Science Systems Solutions, Inc.

WHO

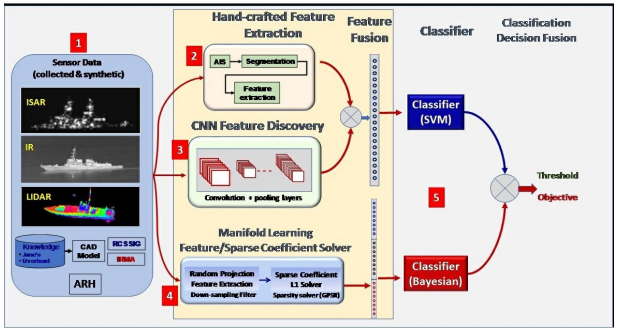
SYSCOM: NAVAIR

Sponsoring Program: H-60 Multi-Mission Helicopter Program (PMA-299)

Transition Target: NAVAIR

TPOC:
(760)939-4477

Other transition opportunities:
Weapon and surveillance platforms



WHAT

Operational Need and Improvement: Radar, electronic support measures (ESM), a.k.a. anti-radiation homing (ARH), electro-optical (EO), imaging infrared (IIR), and laser detection and ranging (LIDAR) currently provide different sensor phenomenology that can lead to different salient feature manifestation, depending on operating conditions (e.g. acquisition geometry) and scene content. Current single-sensor automatic target recognition (ATR) systems, exploit sensor-specific features. ATR systems capable of combining multi-sensor salient features have the potential to improve ship target identification and classification, multi-sensor ATR should result in a higher degree of confidence.

Specifications Required: ATR algorithms designed for execution on mobile processors, to include multi-core system-on-a-chip (SoC) systems, that combine general-purpose computing elements, multi-core advanced reduced-instruction-set-computer machines (ARM) processors, with on-chip co-processors as multi-core graphical processing units (GPUs) and/or field-programmable gate arrays (FPGAs).

Technology Developed: Science System Solutions' (SIGMA-3) state-of-the-art multi-sensor fusion ATR technology leverages advanced machine learning (ML) to provide unprecedented maritime target classification and identification performance on a mobile computing device, deployed onboard severely constrained platforms. These algorithms can be employed by weapon platforms and surveillance platforms.

Warfighter Value: Current Navy operational anti-surface warfare concepts of operations employ intelligence, surveillance, and reconnaissance (ISR) assets to perform the initial track, location, and identification of the enemy fleet. These assets are responsible for locating and identifying the enemy fleet position based on inverse synthetic aperture radar (ISAR) and electronic support measure (ESM) data, and subsequently, relay the processed information to the strike commander (STWC)/firing ship and weapon. Once launched, a weapon must travel hundreds of miles through anti-access/area denial (A2AD) environments without GPS or ISR asset support, and thus must rely on its own onboard organic capability to identify the single adversary capital ship within a surface action group (SAG) consisting of combatants of similar length overall. The technology to be developed under this program will provide a dramatic improvement in target classification and identification capability for space, weight, and power-constrained platforms to support operation in A2AD environments.

WHEN

Contract Number: N68936-19-C-0024 **Ending on:** December 28, 2020

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Generation of IR and ISAR synthetic data	Low	High	3	July 2019
Assessment and enhancement of fusion ATR algorithm	Low	High	3	October 2019
Develop initial software prototype and test against lab data	Low	High	4	December 2019
Software testing against collected data from prime	High	Medium	4	February 2020
Develop initial software package for RDC testing	High	Medium	5	July 2020

HOW

Projected Business Model: SIGMA-3 will develop a software package under this program to be provided to the government with unlimited rights and the prime for integration onto the Program of Record (POR) platform. For potential commercial applications, SIGMA-3 intends to license the software to the prime contractors for integration into the targeted platforms.

Company Objectives: The machine learning multi-sensor fusion ATR technology developed under this SBIR can be employed in wide range applications on numerous Navy and Air Force systems including Tomahawk, MH60-R, Fire Scout, Triton, Poseidon, and CERFER, all of which have dual radar and EO/IR sensor capability. SIGMA-3 has an established relationship with Lockheed Martin, KeyW, ViaSaT, and Boeing, which have significant interests in incorporating SIGMA-3's multi-sensor fusion maritime ATR technology onto their systems.

Potential Commercial Applications: SIGMA-3's fusion technology has a wide range of commercial application in the automotive industry, radar and EO/IR data are employed in collision avoidance systems. Furthermore, maritime activities such as Coast Guard shipping monitoring, and Homeland Security surveillance benefit from SIGMA-3's technology - they need to know what ship traffic exists. In addition, SIGMA-3's core ATR and fusion algorithm can be leveraged in land-based commercial vehicle tracking.

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