

Topic: N162-082

Freedom Photonics LLC

Integrated Analog to Feature Converter

This program targets a photonic analog to feature converter based on optical speckle. This targets electronic warfare applications including compressive sensing, electro-magnetic (EM) spectral awareness, RADAR/Light Detection and Ranging (LIDAR), and other applications that need to identify features in a large information bandwidth. The developed innovation builds on existing compressive sensing algorithms but which incorporates a unique enabling component in the utilization of optical speckle processing, which has the potential for low-power photonic integration. A redesign of the previously developed system based on discrete components to allow photonic integration has been performed. The redesigned system has been validated. The next step will be to push the technology towards further integration and maturity, and to tailor the system towards specific target applications to be defined in collaboration with defense partners/end users.

Technology Category Alignment:

RF Components for sensing, transmission and communication

Contact:

Leif Johansson

info@freedomphotonics.com

(180) 596-74900

<https://freedomphotonics.com/>

SYSCOM: NAVAIR

Contract: N68335-18-C-0089

Booth: 917

Room: Club Room West

Presenting: Apr 11th at 2:30 PM

 Corporate Brochure: https://navystp.com/vtm/open_file?type=brochure&id=N68335-18-C-0089

Department of the Navy SBIR/STTR Transition Program

DISTRIBUTION STATEMENT A. Approved for public release. Distribution is unlimited.

NAVAIR 2018-724

Topic # N162-082

Integrated Analog to Feature Converter

Freedom Photonics LLC

WHO

SYSCOM: NAVAIR

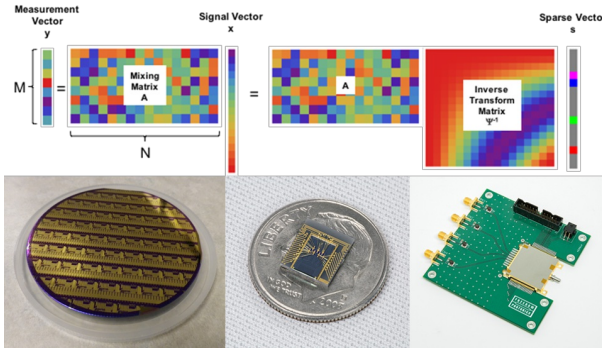
Sponsoring Program: PMA-290
Maritime Surveillance Aircraft

Transition Target: Maritime Surveillance Aircraft

TPOC:
(301)904-4742

Other transition opportunities: Other small power and size-constrained platforms that can benefit from compressive sensing technology. On-board use in Navy aircraft and ships.

Notes: Freedom Photonics is a leading Image courtesy of The Aerospace Corporation and Freedom Photonics, developer of cutting-edge photonic integrated circuits (PIC) and is currently developing advanced high-performance optical component technology for radio frequency (RF) photonic optical links. The "Integrated Analog to Feature Converter" program leverages this development to implement the ultra-compact chip-scale integrated compressive sensing system in development.



Copyright 2018"

WHAT

Operational Need and Improvement: Analog-to-feature converter (AFC) approach that will enable direct conversion of challenging wideband and high dynamic range RF signals to information directly. The key innovation being sought is an implementation approach that accomplishes these functions while significantly reducing the needed size, weight and power required as compared to conventional Analog-to-Digital Conversion/Digital-to-Analog Conversion (ADC/DAC) approaches.

Specifications Required: The computational load on the digital signal processors should be reduced by an order of magnitude and achieve a 10-15 percent reduction in sensor electrical power usage compared to conventional approaches. The packaged front-end should perform over the specified temperature range and maintain hermeticity and optical alignment upon exposure to typical Navy air platform vibration, humidity, thermal shock, mechanical shock, and temperature cycling environments.

Technology Developed: In this program, Freedom Photonics will develop an integrated analog to feature converter utilizing innovative compressive sensing techniques taking advantage of phase stable, repeatable optical speckle transforms. Our approach will be based on novel photonic integrated circuit technology and will take full advantage of close hybrid integration of heterogeneous materials. The proposed system will incorporate a compressive sensing stage in front of the digitizer. This will lead to a 10-1000x reduction in the amount of digitized data and will allow the Navy to move to future ultra-broadband RF front-end systems rapidly assuming current trends in ADC and signal processing capability.

Warfighter Value: Compressive sensing is a key enabling technology for electronic warfare and spectral dominance. The proposed solution would offer a chip-scale integrated photonically enabled compressive sensing approach with an order of magnitude lower power than brute force digitization and a size and weight orders of magnitude lower than photonic approaches demonstrated to date. This will allow the implementation of compressive sensing systems onto small size and power constrained platforms where previously this was not possible.

WHEN

Contract Number: N68335-18-C-0089 **Ending on:** February 26, 2020

| Milestone | Risk Level | Measure of Success | Ending TRL | Date |
|---------------------------------------|------------|--|------------|---------------|
| Completed system integration and test | Low | Complete system assembled using fabricated components | 3 | August 2019 |
| Laboratory system demonstration | Low | Initial system demonstration meeting program performance targets | 4 | February 2020 |
| Integrated hardware unit deliverable | Med | Integrated module meeting SWaP targets | 5 | February 2021 |
| Final system demonstration | Med | Final demonstration using integrated prototype | 5 | February 2021 |

HOW

Projected Business Model: Freedom Photonics perceives a significant commercial opportunity in the development of ultra-wideband, low-power RF photonic front-ends to address the ever-faster acquisition and transmission rates required by DOD electronic warfare (EW) applications, as well as a new military and commercial communications, sensing and surveillance systems. Freedom Photonics intends to directly manufacture and sell the developed integrated compressive sensing / RF photonic products that is a secondary outcome of this program. The company operates under a manufacturing model where semiconductor photonic chip fabrication is outsourced (fabricated to our proprietary design) followed by chip and module assembly and test which is performed in-house. This approach is extremely cost effective and provides great flexibility.

Company Objectives: Freedom Photonics will continue to mature this technology throughout this effort. Once TRL 5 has been reached, we intend to pursue a wider potential market for DOD compressive sensing applications and other commercial implementations. Prime system integrators will be approached to evaluate potential insertion opportunities at this point. Continued interaction with NAVAIR and other DOD branches will be pursued to further develop the technology for this wider target application field.

Potential Commercial Applications: Potential markets under consideration are:

- On-board use in aircraft and ships
- Radar systems
- Electronic warfare systems
- Parallel applications in computing systems

Contact: Leif Johansson, CTO
info@freedomphotonics.com

18059674900

Topic: N14A-T008

Mayachitra, Inc.

Foveated Video Object Recognition

Human ability to search for objects in visual scenes is unsurpassed by current automated techniques. Performance of overhead sensor data state-of-art region saliency and object recognition is degraded by low resolution data quality, object-of-interest size, view occlusions, and crowded scenes. To successfully detect objects in cluttered scenes, the human brain relies on multiple factors: prior object occurrence probability, global scene statistics, and object co-occurrence. Mayachitra's proposed solution provides efficient and effective small object detection from overhead noisy (crowded occluded) videos. The proposed technology enables collection speed data labeling, and intelligence mining. Benefits are multi-tiered: analyst time is optimized through reduction/elimination of mundane viewing tasks; multiple search, tagging, discover, data access and analysis capabilities are provided; intelligence is derived and verified in a fraction of time; and no data is thrown away providing analysts the capability to explore archival data.

Technology Category Alignment:

EO/IR Components for sensing, transmission and communication

Guidance, Navigation & Control (GN&C) and Data Links

Electro-Optical/Infrared (EO/IR)

Human/Autonomous System Interaction and Collaboration

Machine Perception, Reasoning and Intelligence

Contact:

Elliot Staudt

staudt@mayachitra.com

(805) 967-9828

<https://mayachitra.com/>

SYSCOM: NAVAIR

Contract: N68335-18-C-0199

Booth: 916

Room: Club Room West

Presenting: Apr 11th at 2:10 PM

 Corporate Brochure: https://navystp.com/vtm/open_file?type=brochure&id=N68335-18-C-0199

Department of the Navy SBIR/STTR Transition Program

DISTRIBUTION STATEMENT A. Approved for public release. Distribution is unlimited.

NAVAIR 2018-684

Topic # N14A-T008

Foveated Video Object Recognition

Mayachitra, Inc.

WHO

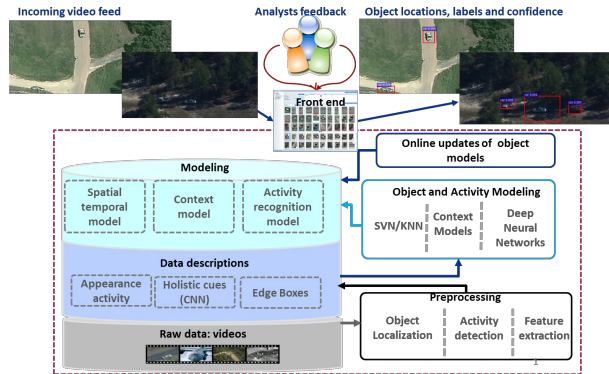
SYSCOM: NAVAIR

Sponsoring Program: PMA-281 Strike Planning and Executions Systems

Transition Target: PMA-281's Common Control System (CCS) for Unmanned Systems implements a software and user interface architecture that provides common vehicle management, mission planning and mission management capabilities for all future Navy unmanned air vehicles (UAVs), including unmanned air systems (UAS). Mayachitra's advanced visual information processing capabilities are targeted for early adoption and integration into the CCS architecture.

TPOC:
(301)757-1884

Other transition opportunities: All programs that fly UAS and collect electro-optical (EO) sensor video data. Potential transition candidates include NAVAIR's Persistent Maritime Unmanned Aircraft Systems (UAS) (PMA-262), NAVAIR's (PMA- 265) Tactical Aircraft Programs, and the Naval Air Weapons Station (NAWS) China Lake.



Copyright, 2018, Mayachitra, Inc

WHAT

Operational Need and Improvement: Employment of advanced automated and semi-automated techniques enables enhanced identification opportunities from useful unseen data, and provides support to task saturated intelligence officers and staff. Future operations will require faster, more accurate methods to assess visual data that combine traditional human evaluation and automated techniques. Low-resolution quality of operational data, size of objects of interest, view occlusions, and crowded scenes degrade the performance of state-of-art region saliency and object recognition approaches applied to overhead sensor data.

Specifications Required: Automatically detect and recognize the multitude of objects of potential interest providing an object recognition decision with a high level of confidence - it is critical to understand the performance and performance evaluation; to perform object recognition/cueing in real to near-real-time on medium to high-end desktop computers.

Technology Developed: Mayachitra has developed technology to automatically detect and recognize objects of potential interest from overhead video and sensor imagery, which provides object recognition decision with a high level of confidence. Efficient and effective object recognition is performed in real to near-real-time and can be executed on low size, weight, and power (SWaP) Unmanned Aerial Surveillance (UAS) processors. Mayachitra's technology employs state-of-art deep learning and foveated video object recognition techniques to efficiently and effectively detect small objects from overhead noisy (crowded occluded) videos, where state-of-art models fail. The technology integrates a suite of the support modules to enhance user interaction.

Warfighter Value: Reduction in un-evaluated data from sensors used due to lack of resources required to evaluate the data collected. Reduction in workload for intelligence officers and their staff. Higher hit rate on targets of interest and less false alarms on innocuous or friendly objects. Tasks processed on the platform to reduce data smog.

WHEN

Contract Number: N68335-18-C-0199 **Ending on:** March 22, 2019

| Milestone | Risk Level | Measure of Success | Ending TRL | Date |
|---|------------|---|------------|----------------|
| Optimize the architecture design of the deep learning network to support small object recognition | Low | Prototype demonstration with relevant data sets | 6 | September 2018 |
| Object recognition at multiple levels of description. | Low | Average precision | 6 | July 2019 |
| Tune the modeling pipeline to meet precision recall demands | Med | Average precision | 6 | September 2019 |

HOW

Projected Business Model: Mayachitra's is initially focused on the Department of Defense (DoD) U.S Navy, U.S Air Force, and U.S. Marine Corps to support technology transfer through sales, support contracts, and licensing agreements.

Company Objectives: Mayachitra's technology automatically detects and recognizes multitudes of objects of potential interest providing a high confidence, near real-time, object recognition decision capability for processed electro-optical/infrared (EO/IR) sensor imagery. In today's environment warfighters are faced with an exponential increase in available overhead video sensor data. Based upon changes in the battlefields many different types of pre-mission objects of interest are anticipated – the proposed technologies' active learning component provides operators the capability to find objects of interest in real time given various operating environmental parameters, backgrounds, clutter, weather, etc. Mayachitra's primary objective is to connect its technology with interested PMAs and NAVAIR Labs, to mature capabilities under technology insertion initiatives, adapt the capability to meet the needs of the greater UAS community, and deploy the capability through Navy program of record to support theater operations

Potential Commercial Applications: This technology would be useful for the United States Coast Guard (USCG), Department of Homeland Security (DHS), Department of Energy (DOE), and other federal agencies for which protection from vehicle-based threats is important. Commercial security entities could likewise benefit from automated processing of imagery data. Federal, state and commercial rescue organizations could also benefit from the ability to track objects. All organizations, for which remote imagery is valuable, could potentially benefit from this technology.

Contact: Elliot Staudt, Principal Investigator
staudt@mayachitra.com (805)967-9828

Topic: N161-013

Mayachitra, Inc.

Image Correspondence Figure of Merit (FOM)

Mayachitra leverages recent advances in deep learning and computer vision to deliver robust solutions to critical problems in multimodal data analysis and cyber security. Mayachitra's effort is aimed at taking the guesswork out of the analyst's job to improve accuracy and reliability by developing a Figure of Merit (FOM). The approach scans an image using a condition theoretic approach to isolate strong line and corner information, present in the image. It also examines the distribution of that information about the image. Mayachitra then quantifies the quality of the image with respect to registration potential. A Graphical User Interface (GUI) is provided to streamline the analyst's interaction with the FOM. The GUI provides extended functionality to intuitively access and process data on demand.

Technology Category Alignment:

EO/IR Components for sensing, transmission and communication

Guidance, Navigation & Control (GN&C) and Data Links

Electro-Optical/Infrared (EO/IR)

Human/Autonomous System Interaction and Collaboration

Machine Perception, Reasoning and Intelligence

Contact:

Elliot Staudt

staudt@mayachitra.com

(805) 967-9828

<https://mayachitra.com/>

SYSCOM: NAVAIR

Contract: N68936-17-C-0061

Booth: 916

Room: Club Room West

Presenting: Apr 11th at 2:20 PM

 Corporate Brochure: https://navystp.com/vtm/open_file?type=brochure&id=N68936-17-C-0061

WHO

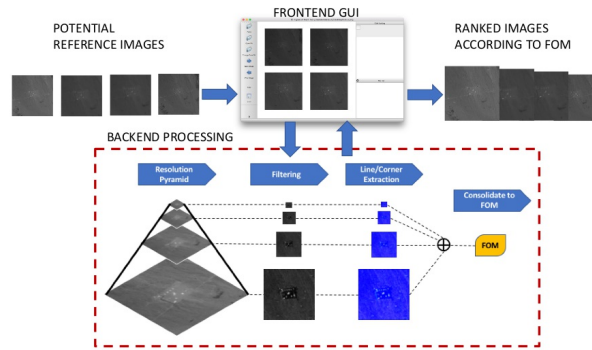
SYSCOM: NAVAIR

Sponsoring Program: PMA 201
Precision Strike Weapons

Transition Target: Image-Guided Weapons

TPOC:
(760)939-0044

Other transition opportunities: This technology is applicable to all US Air Force, Navy, Army, and Marine Corps Image-Guided Weapons



Copyright 2018, Mayachitra

WHAT

Operational Need and Improvement: Current mission planning capability for image-guided weapons are limited. When planning to employ these weapons, images are used to aid in the target acquisition process and to guide the weapon to the target. Images used during the mission planning phase may be from any of a number of sources and may be screened for potential best or optimal success in aiding the weapon, based upon content, clarity, and/or mode. What is needed is a simulation or method that can compare images and provide a measure or figure of merit (FOM) for the level of correspondence that should be expected, so that the best image can be selected and used.

Specifications Required: When multiple images are available, the mission planning system can use the FOM, statistical measure, and the simulation to find the image that would give them the highest success rate for the mission. For example, the simulation would only look at the images with a FOM greater than a predetermined critical value - images with the most unique features. Simulation is leveraged to determine a weapon's performance using the planned profile in a design of the experiment. This will determine how many times the weapon will be correlated to within tolerance using each image. Using these results, the simulation would provide the best image needed to achieve mission success.

Technology Developed: Mayachitra's Phase II effort is aimed at taking the guesswork out of the analyst's job to improve accuracy and reliability by developing a Figure of Merit (FOM). The approach scans an image using a condition-based theoretic approach to isolate strong line and corner information, present in the image. It also examines the distribution of that information about the image. Mayachitra then quantifies the quality of the image with respect to registration potential. A Graphical User Interface (GUI) is provided to streamline the analyst's interaction with the FOM. The GUI provides extended functionality to intuitively access and process data on demand.

Warfighter Value: The proposed technology simplifies the job of an analyst when choosing a reference image for image registration. Analysts are typically provided with a group of images that overlap a target area. They are tasked with choosing the best among those images to serve as a reference image. However, the qualities that separate good images from mediocre images are subtle and difficult to gauge by eye alone. There are high stakes involved with target acquisition. Any improvements we can make to accuracy and reliability will have immediate and long-term benefits.

WHEN

Contract Number: N68936-17-C-0061 **Ending on:** March 25, 2019

| Milestone | Risk Level | Measure of Success | Ending TRL | Date |
|--|------------|--|------------|---------------|
| Establish FOM against limited set of images | Low | Software interfaces with end user hardware and performs to specifications | TRL-4 | February 2018 |
| Establish Function GUI | Low | Software environment functions to support arrays of any size and curvature | TRL-4 | December 2018 |
| Test and Evaluation of FOM simulation against real data sets | Med | Correlation with supplied imagery and NAVAIR metrics | TRL-5 | February 2019 |

HOW

Projected Business Model: Mayachitra initially focused on the Department of Defense (DoD) Navy, Airforce, and Marine Corps to support technology transfer through sales, support contracts, and licensing agreements.

Company Objectives: Mayachitra's technology automatically detects and recognizes multitudes of objects of potential interest providing a high confidence, near real-time, object recognition decision capability for processed electro-optical/infrared (EO/IR) sensor imagery. In today's environment warfighters are faced with an exponential increase in available overhead video sensor data. Based upon changes in the battlefield many different types of pre-mission objects of interest are anticipated – the proposed technologies' active learning component provides operators the capability to find objects of interest in real-time given various operating environmental parameters, backgrounds, clutter, weather, etc. Mayachitra's primary objective is to connect its technology with interested Program Management Activities and NAVAIR Labs, to mature capabilities under technology insertion initiatives, adapt the capability to meet the needs of the greater unmanned aerial surveillance (UAS) community, and deploy the capability through Navy program of records to support theater operations.

Potential Commercial Applications: This technology would be useful for the United States Coast Guard (USCG), Department of Homeland Security (DHS), Department of Energy (DOE), and other federal agencies for which protection from vehicle-based threats is important. Commercial security entities could likewise benefit from automated processing of imagery data. Federal, state and commercial rescue organizations could also benefit from the ability to track objects. All organizations, for which remote imagery is valuable, could potentially benefit from this technology.