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:

Advanced Electronics

RF Components for sensing, transmission and communication

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SYSCOM: NAVAIR

Contract: N68335-18-C-0089

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

Department of the Navy SBIR/STTR Transition Program

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NAVAIR 2018-724

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Integrated Analog to Feature Converter

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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.

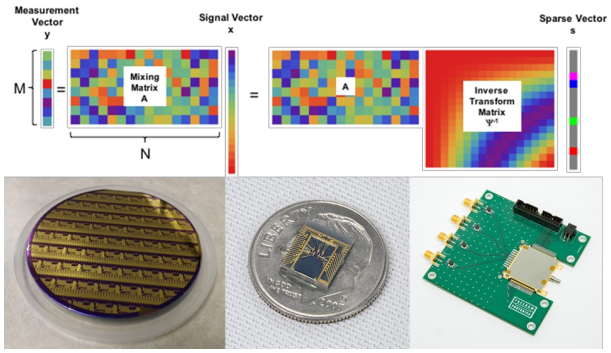

Image courtesy of The Aerospace Corporation and Freedom Photonics, Copyright 2018"

Notes: Freedom Photonics is a leading 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.

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 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

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