Topic: N181-022

Physical Sciences Inc.

Laser Periscope Detection

PSI’s high-speed, visible-near infrared/shortwave infrared hyperspectral imager will enable minefield detection through novel, staring-mode system architecture and automated anomaly and target detection algorithms. The sensor is designed to detect minefields consisting of surface laid mines and obstacles as well as buried mines from an unmanned aerial system (UAS) platform with high spatial/spectral resolution and minimal motion-induced artifacts. The sensor also has applications to UAS-borne intelligence, surveillance and reconnaissance (ISR) missions. Performance has been demonstrated under limited operational conditions. PSI is a leader in the development of novel, spectro radiometric and hyperspectroscopic sensors with accompanying detection algorithms for field-based and airborne platforms for military and aerospace markets. Our ultimate goal is to transition this technology to government or prime contractors for ISR and minefield detection.

Technology Category Alignment:

Sensors
Air Platforms
Advanced Electronics

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SYSCOM: NAVSEA
Contract: N68335-20-C-0286

Corporate Brochure: https://navystp.com/vtm/open_file?type=brochure&id=N68335-20-C-0286

Tech Talk: https://www.youtube.com/watch?v=R92fJ1g-oh8

Department of the Navy SBIR/STTR Transition Program

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NAVSEA #2020-0363

Topic # N181-022

High Speed VNIR/SWIR HSI for AIrborne Mine Detection

Physical Sciences Inc.

WHO

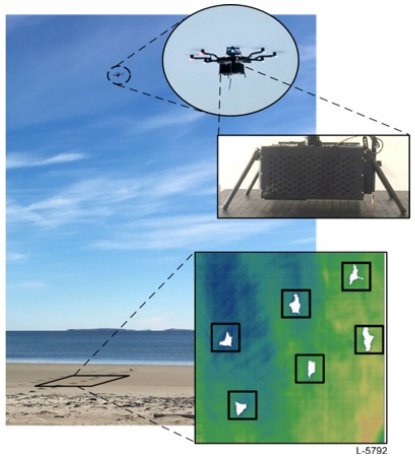
SYSCOM: NAVSEA

Sponsoring Program: PMA 299 (ASW) H-60 Helicopter Program; PEO USC, PMS 495 Mine Warfare

Transition Target: H-60 multi-mission helicopter program, Coastal Battlefield Reconnaissance and Analysis (COBRA) System, MQ-8 Fire Scout

TPOC:
(850)235-5423

Other transition opportunities: Other transition opportunities include minefield (surface laid and buried) detection in non-littoral zones, and UAS-borne intelligence, surveillance and reconnaissance (ISR) missions.



Images courtesy of Physical Sciences Inc.

Notes: The image depicts the unmanned aerial system (UAS)-borne visible-near infrared/shortwave infrared hyperspectral imager (VNIR/SWIR HSI) deployed over a beach with a simulated minefield. The insets include a close-up of the sensor mounted to an octocopter UAS, the sensor itself, and detection map showing detection of six regions of disturbed sand (highlighted in black squares).
Physical Sciences Inc (PSI) has a long history of developing advanced technologies and products for the military and commercial markets and has multiple examples of technology developments that have resulted in both commercial success and successful transition into DoD systems. **For every dollar of Phase II SBIR investment, PSI has secured nearly 3 times that amount in Phase III funding.**

WHAT

Operational Need and Improvement: Minefields function to immobilize and/or deny vehicle and troop movement. The Navy requires sensors to conduct unmanned aerial tactical reconnaissance in the littoral battlespace for detection and localization of minefields and obstacles in the surf zone and beach zone prior to an amphibious assault. This allows operators and other personnel to remain at a safe distance from the mine and obstacle belts and enemy direct and indirect fire.

Specifications Required: The sensor will be capable of detecting buried and surface mines and improvised explosive devices during daytime operation over beach zones with a probability of detection of 90% and a probability of false alarm of 1%. The system will be compatible with a UAS at an altitude of 3000 ft and a velocity of 60 m/s.

Technology Developed: PSI is developing a **beach-zone minefield detector that employs a novel, high-speed VNIR/SWIR HSI coupled to automated anomaly and target detection algorithms**. The sensor is designed to detect minefields consisting of surface laid mines and obstacles as well as buried mines. The sensor architecture enables rapid staring-mode hyperspectral data acquisition that supports a fast speed of advance and high specificity for airborne mine detection. Furthermore, the staring mode data acquisition decouples the aircraft motion from the sensor, yielding high fidelity spatial images. The integrated advanced detection algorithm performs in situ characterization and elimination of spectral/spatial beach clutter, anomaly detection, and spectral/shape/feature matching against key targets.

Warfighter Value: The sensor will 1) **provide hyperspectral imagery with optimized spectral/spatial resolution and signal to noise ratio (SNR) for separation of mine spectra/spatial features from beach zone clutter**, 2) perform **real-time in situ clutter analysis and separation of anomalies and targets** based on spectral and spatial features, and 3) remotely inform the warfighter of minefields. The SWIR has been demonstrated to be more sensitive to soil and sand moisture than visible wavelengths, especially when efforts have been made to disguise the disturbed earth by smoothing the top layer. Furthermore, receiver operator curves (ROCs) show an enhanced probability of detection of surface laid mines with a lower false alarm rate for hyperspectral data versus currently employed multispectral imagery.

WHEN

Contract Number: N68335-20-C-0286 **Ending on:** December 17, 2021

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Ground and airborne tests were conducted for disturbed soil and sand at local sites	N/A	Demonstrated discrimination between surface types, and disturbed soil and sand	5	December 2018
Data collection on a manned UH-1 of a simulated minefield	N/A	Demonstrated ability to detect surface and buried mines	5	December 2019
Next generation design built and functionally tested	Low	Critical design review package	5	September 2020
Initial developmental testing of the system deployed on an in house UAS in a beach zone	Med	Functional test report meeting programmatic KPPs	5	March 2021
Sensor and algorithm updates based on the developmental testing	Med	Updated critical design review and functional test report	6	September 2021
Conversion of the algorithms to executable code to provide real-time detection maps	Med	Completed executable software package	6	March 2022

HOW

Projected Business Model: PSI intends to market the VNIR/SWIR HSI payload as an original equipment manufacturer (OEM) subsystem to a system integrator. PSI is currently equipped with a 10,000 sq. ft. space with assembly benches and appropriate tools, a clean room section, storage bins, a stock and inventory area, and documentation controls, as well as a manufacturing resource planning (MRP) system. PSI will provide pre-production efforts to qualify vendors, establish the supply chain, develop user documentation and manuals, and establish manufacturing processing and procedures. This will lead to low rate initial production.

Company Objectives: PSI develops advanced technologies and products for the military, aerospace, industrial process, energy, telecommunications, environmental, and medical markets. PSI is strongly committed to developing products and services based on innovative technologies developed under the SBIR program and has transitioned numerous technologies to support the missions of the Department of Defense, NASA, EPA, and many commercial partners throughout the entire history of the SBIR program. **PSI has multiple examples of technology developments that have resulted in both commercial success and successful transition into DoD systems**, including radiation detection technology and remote methane leak detector technology.

Potential Commercial Applications: There are currently no commercially available staring-mode hyperspectral imaging systems with comparable size, weight, and power (SWaP) and spectral range and sensitivity as the PSI VNIR/SWIR HSI. Potential commercial applications include UAS-borne ISR missions, standoff chemical and explosives detection, vegetation trait mapping, and precision agriculture.

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