Department of the Navy SBIR/STTR Transition Program

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NAVSEA #2021-0437

Topic # N193-A02

N193-A02 Unmanned Surface Vehicle (USV) and Unmanned Underwater Vehicle (UUV) Autonomous Behavior Development

Vy Corporation

## WHO

SYSCOM: NAVSEA

Sponsoring Program: PMS 406

Transition Target: Dual Use: Subsurface threat detection and collision avoidance in autonomous vehicles and signal separation for ASW

TPOC:
401-832-5297

Other transition opportunities: Automated Target Recognition (ATR) with no training and auditable decision trail in different lighting conditions, in conditions involving occlusions and cluttered backgrounds, shadows (occlusions of lighting) and other appearance variables.

Notes: Automatic target recognition (ATR) is the ability for an algorithm or device to recognize targets or other objects based on data obtained from sensors. Common sensors include radar, sonar, and lasers. Highly skilled operators are used to interpret signals from ATR sensors. As the demand for autonomous UXV operations and behavior in both hostile and friendly environments steadily increases, new approaches will be required. Automated detection of targets currently requires the creation of extensive training databases and various deep learning techniques to outperform conventional methods. Conventional deep learning systems are dependent on RGB color input which is highly variable and relies upon many thousands of manually generated training vectors for real-world use cases which must be manually labeled. Additionally, these deep learning systems lack auditability and transparency: there is no way to explain how their decisions are made.
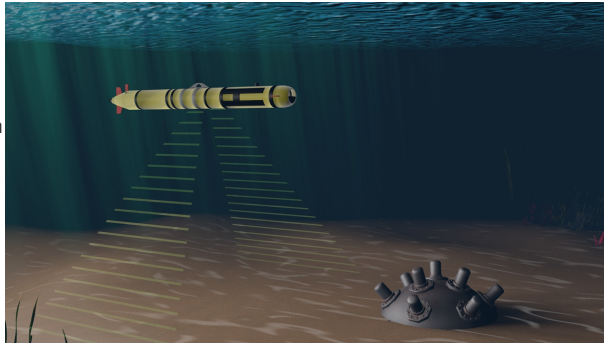
Fully Autonomous Sub Surface Threat Detection - Image courtesy of Vy Corporation

WHAT

Operational Need and Improvement: Automated pattern and anomaly recognition, collision avoidance, and fully autonomous decisions.

Specifications Required: API Suitable for integration with the Navy's Common Control System (CCS) and Unmanned Autonomy Architecture (UMAA)

Technology Developed: Dual-Use Application Programming Interface (API) for sub surface mine detection using side scan sonar and signal separation for acoustic whale data. Development of Docker Container has created a framework to facilitate pipeline analysis services tied to customer needs and available computing capacity. This approach allows the customer to choose which elements happen on the unmanned underwater vehicle (UUV) and which elements can be completed post mission. Deliverables include three serial elements: post mission analysis, tethered target ID during mission, and fully autonomous Automated Target Recognition (ATR).

Warfighter Value: Improve UMAA Stack Reliability through sensor fusion, transparency, and auditability. Fully autonomous decisions. Shape-Based Modeling Segmentation acoustic signal separation analysis from a noisy background facilitates superhuman performance.

ATR
New approaches to reduce training time, improve reliability, and provide an auditable methodology for continuous ATR improvement is highly desirable.

Signal Separation/Adaptive Filtering
There have been few advances in signal separation and adaptive filtering in the last twenty years. New threats have created an immediate need for a methodology capable of finding and characterizing signals at a super-human level. Using Fast Fourier Transforms (FFTs) to expand signal time data, Vy's SBMS technology can be used to fit Polynomials (MetaBéziers) to orderly parts of spectrogram signal data to eliminate virtually all noise and achieve super human performance. We call this technology "Project Jonesy" in honor of the "super-human" sonar operator in The Hunt for Red October.

WHEN

Contract Number: N68335-20-F-0592   **Ending on:** November 5, 2021

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Collect Representative Sample of Real World Data	Low	At least 30 sub surface threat samples & several hours of whale calls and ship noise.	7	December 2020
Improve throughput and processing time	Low	Minimum 20X improvement; currently achieving greater than 50X	7	October 2021
QGIS Plug-in for Vectorized Geo-Referenced data	Low	Operational plug-in to create novel new data layers	7	September 2021
Package Software as a Scalable Docker Container	Low	Infinite scalablity	8	March 2021
Sub Surface Mine Threat Model Demonstration	Med	Greater than 80% ROC	7	October 2021
Adaptive Filtering by Signal Domain Vectorization Demonstration	Med	Greater than 85% RCC	5	October 2021

HOW

Projected Business Model: Vy's SaaS (Software as a Service) Platform is offered through the IBM Marketplace and others. Customers are charged based upon usage. Pricing is tied to the size of each image, volume, number of users, storage, and support calls. Subscriptions for larger computing blocks are available on a month to month and an annual basis. For customers requiring on site computing, Vy's Shape Based Modeling API (application programming interface) is available in a docker container packaged as a PaaS (Platform as a Service). We offer special projects works for customers requiring custom model development and consulting services, For larger customers, a project manager is assigned to the account to help meet the customer's current and future needs.

Company Objectives: Vy Corporation ("Vy", or the "Company") Vy is an artificial intelligence software company. The company has developed and patented a platform to vectorize and make decisions about "big data" imagery generated by satellite, video, sonar and radar, the platform is called Shape-Based Modeling Segmentation (SBMS). This allows for: Superhuman performance (novel new data streams), auditable and transparent decision-making. Faster, more reliable recognition and characterization. The platform uses mathematical models called Bézier curves and decision trees to vectorize visual and hyperspectral imagery and save it in an industry standard database (SQL). Vectorization turns related pixels into mathematical functions. Key competitive differentiators are the ability to query our novel vectorized image data using widely available tools like Python, as well as an ability to fuse our data with existing platforms and systems to make faster and more reliable decisions.

Potential Commercial Applications: Vy's SaaS platform optimizes image recognition for cost-effective customizable industry-agnostic data accumulation, analysis and reporting of real-time actionable information. Targeted commercial verticals include: satellite image analysis, insurance underwriting/claims, utility maintenance/inspection, agriculture/climate change, and life science/drug discovery. There is an increasing need for super human data analysis capabilities; Vy offers transformational vectorization technology for fully automated satellite image analysis with no training and up to 100 to 1 convergence efficiencies.

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