Department of the Navy SBIR/STTR Transition Program

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NAVSEA #2020-0480

Topic # N181-044

Turbulence Mitigation, Error Reduction, and Increased Contrast (TURMERIC)

Charles River Analytics Inc.

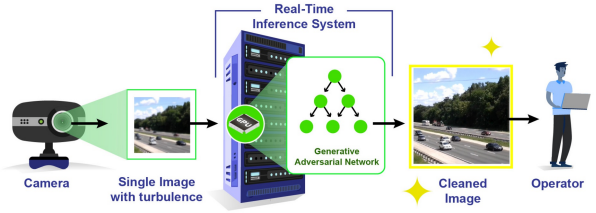
WHO

SYSCOM: NAVSEA

Sponsoring Program:

Transition Target: AxB

TPOC:
(401)832-5220



Other transition opportunities: Our capability can transition to imaging systems used by surface vessels with minimal modifications. We are currently working with L3Harris Cincinnati Electronics to transition the TURMERIC algorithm to the FarSight system. The FarSight system enables computer vision algorithms to be used for multiple capabilities, including counter-Unmanned Aerial System (counter-UAS) and shipboard protection. We are further pursuing opportunities to apply the TURMERIC capabilities to base security and defense, and have submitted AFWERX and Rapid Innovation Fund (RIF) proposals in support of this goal.

Notes: Charles River Analytics has experience deploying software to Government systems. For example, SAVANT was a TRL 9 operational software system as part of a Program of Record. It was a suite of workflow support tools designed to drive doctrinally defined processes and procedures. SAVANT underwent multiple formal assessments, was frequently trained to active duty and reservist forces, and was deployed for operational use.

WHAT

Operational Need and Improvement: Collected digital imagery may contain distortions due to atmospheric turbulence caused by humidity and temperature gradients near the ocean surface, and comes from a moving camera capturing a moving target in a moving scene. We are developing Turbulence Mitigation, Error Reduction, and Increased Contrast (TURMERIC), a software system that uses deep learning to correct for atmospheric turbulence in imagery in real time so that operators and automated detection algorithms can optimally detect surface contacts. TURMERIC uses a generative adversarial network (GAN), a powerful deep learning architecture, to intelligently de-blur and enhance the contrast of collected imagery.

Specifications Required: The system is required to run in real-time (30 Hz) on 1080p imagery in order to make it operational. We leverage the computing power of Graphical Processing Units (GPUs) to make this capability possible. The system additionally uses only a single frame in order to both mitigate high platform movement and minimize latency between frame collection and delivery to the operators.

Technology Developed: We have developed a Deep Learning (DL) model trained through a GAN framework which is able to sharpen and de-noise imagery collected from cameras in real-time. The GAN is trained using simulated atmospheric turbulence data created using a physics-based atmospheric turbulence simulator, which enables the model to more accurately learn the characteristics of turbulence encountered in the real world, and therefore enables improved mitigation of encountered distortions. The model runs on a rapid deep neural network inference framework that is able to parallelize calculations across multiple GPUs, maximizing inference speed.

Warfighter Value: The TURMERIC system enables optimal exploitation of imagery collected by digital sensors. Using the TURMERIC system, operators and downstream image processing algorithms are able to rapidly and more easily understand the content of imagery, enabling quicker assessment and response to the content of the imagery. Digital video cleaned by the TURMERIC system can be fed directly into an ensemble of automated image processing algorithms to improve the performance of these algorithms, including target detection, tracking, and classification. Improved performance of these automated algorithms relieves burden on sensor operators, contributes to enhanced situational awareness, and improves overall mission effectiveness.

WHEN

Contract Number: N68335-19-C-0656 **Ending on:** September 26, 2021

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Turbulence Removal Proof of Concept	Low	System can mitigate turbulence on 1080p imagery	4	September 2020
Real-Time System Performance	Low	Real-time denoising on 1080p Imagery	5	September 2020
Adaptive Enhancement of Imagery	Med	System can automatically and adaptively remove complex turbulence noise sources	6	June 2021

HOW

Projected Business Model: Charles River Analytics conducts leading-edge AI, robotics, and human-machine interface R&D and leverages that R&D to create custom solutions for your organization. We have a stellar track record developing successful solutions for Government and commercial clients across a diverse collection of markets—defense, intelligence, medical technology, training, transportation, space, and cyber security. Our success is based on our expertise with advanced algorithms, machine learning, autonomous systems, advanced human-system interfaces, and agile software and hardware engineering. Charles River Analytics will license the TURMERIC technology for use on NAVSEA systems.

Company Objectives: Charles River Analytics will further develop this technology, along with other existing capabilities included in our extensive VisionKit® library of image processing algorithms, to become a leader in commercial image enhancement algorithms. We're targeting transition into platforms where imaging under turbulent conditions is common.

Potential Commercial Applications: The TURMERIC capability has extensive commercial applications. In particular, no existing image enhancement systems work in real time on a single frame. We hope to apply the TURMERIC capability to surveillance and protection systems, enabling the detection of incoming threats at greater distances than previously possible under turbulent conditions. Since our capability only requires a single frame, images can be enhanced from platforms moving rapidly over rough seas (e.g., a small boat) or rough terrain (e.g., a vehicle). TURMERIC can furthermore be applied to base protection systems, allowing the detection of far-off UAS moving quickly across frames that would previously been obscured by turbulence and potentially confused with birds.

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