Department of the Navy SBIR/STTR Transition Program

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NAVAIR Public Release 2021-720

Topic # N181-017

Onboard Turbulence Recognition System for Improved UAS Operator Situational Awareness

Barron Associates, Inc.

WHO

SYSCOM: NAVAIR

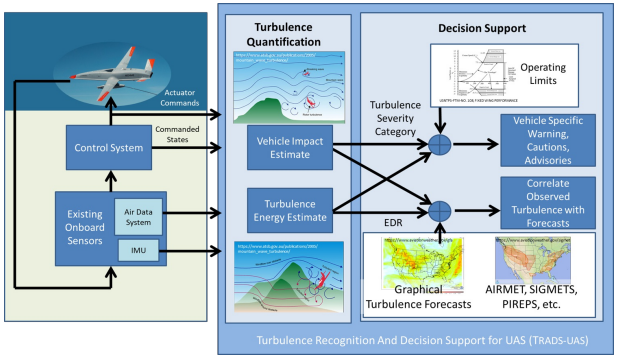
Sponsoring Program: PMA-268

Transition Target: MQ-25

TPOC:
(301) 995-2038

Other transition opportunities: MQ-4C, RQ-21A, MQ-9A, RQ-4B, MQ-1C, RQ-7, RQ-11, RQ-20, MQ-27

Notes: The Turbulence Recognition and Decision Support for UAS (TRADS-UAS) System provides operators of unmanned vehicles with actionable information on the current turbulence environment, restoring important turbulence-related situational awareness that can be lost without an onboard pilot. It achieves this using only existing onboard flight control sensors, and with a low computational burden. Outputs of the system allow operators to readily understand the turbulence environment in the context of vehicle operating limits, and aviation weather products.



Courtesy of Barron Associates 2021

WHAT

Operational Need and Improvement: Unmanned aircraft perform critical missions for the Navy and must manage turbulence to maintain safe operations, minimize maintenance costs, and maximize aircraft availability and lifetimes. Manned aircraft pilots manage turbulence effectively but situational awareness of turbulence is challenging for ground-based unmanned vehicles operators. While turbulence levels may be inferred through indirect clues like airspeed fluctuations, such approaches are unreliable and increase operator workload significantly. Automated systems are needed to accurately quantify turbulence levels and provide actionable information to ground-based operators. In the longer term, this information will be used by vehicle systems to autonomously respond to turbulence.

Specifications Required: Turbulence quantification systems must have minimal impact on size, weight, power consumption, and cost. Ideally, the systems will require no added sensor hardware and employ algorithms with low computational burdens. The systems must account for the characteristics of specific vehicles including vehicle configuration and loading and provide turbulence measures that can be related to the aircraft's operational limitations. The systems must provide turbulence measures correlated to standard aviation weather products.

Technology Developed: TRADS-UAS employs a two-pronged approach to turbulence quantification: a vehicle independent turbulence quantification component and a vehicle impact estimation component. The vehicle independent component focuses on quantifying turbulent energy in the atmosphere, provides outputs that correlate to standard aviation weather products, and facilitates effective information sharing across the fleet. The vehicle impact component is focused on how turbulence is affecting the vehicle. This component accounts for the fact that turbulence impacts vary based on vehicle size, speed, wing loading, operating limits, etc., and the same turbulence environment may be safe for one vehicle but exceed the limits of others. TRADS-UAS fuses information from these two components and provides human operators with warnings, cautions, and advisories that reflect the operating limits of that vehicle.

Warfighter Value: TRADS-UAS enhances the safety of UAS operations, reduces maintenance costs and extends aircraft lifetimes. It will support operations with ground-based operators and future operations with higher automation levels. For MQ-25, it will enable the vehicle to reliably be in a suitable turbulence environment before receiver aircraft arrive, enhancing safety and efficiency of refueling operations.

WHEN

Contract Number: N68335-19-C-0407 **Ending on:** June 5, 2023

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Simulation-based testing of TRADS-UAS	Low	Accurate estimation of known turbulence levels	4	November 2020
Flight tests on general aviation aircraft	High	Accurate turbulence estimates validated by onboard pilot/engineers and ground-based sensors	5	October 2021
Flight test on business jet	Med	Accurate estimates of high altitude turbulence validated by onboard pilots/engineer	5	June 2022
Demonstration in conjunction with MQ-25 flight tests	Med	Accurate turbulence estimates validated against forecast and chase aircraft reports	7	May 2023

HOW

Projected Business Model: Barron Associates intends to license the patent pending technology to air vehicle manufacturers to incorporate either as an onboard capability (allowing system outputs to be used either by vehicle automation systems or by ground-based operators) or as a ground-based capability (typically providing information to ground based vehicle operators and/or flight test engineers). Barron will also license the technology to end users of vehicles (including the Navy), who are expected to employ ground-based implementations. Barron will support TRADS-UAS deployment on new vehicles with Engineering Services to assist with initial integration and customization.

Company Objectives: Barron will transition TRADS-UAS to the Navy to support MQ-25 flight test and transition the technology to the operational fleet with Boeing as part of a Phase III effort, in collaboration with PMA and RT&E groups. Barron will seek to incorporate the technology into a broad range of military UAS through collaborations with additional prime contractors. By working with prime contractors to integrate the technology into unmanned vehicles as an onboard capability, it will be positioned to support future operations with higher levels of autonomy in which outputs of the TRADS-UAS system are used directly by vehicle automation systems. Barron Associates will seek licensing agreements and engineering support contracts to transition the technology to new vehicles. After initial transition to military applications, Barron's objective it to expand into civilian applications as potential growth margins have dramatically increased with the development of Advanced Air Mobility vehicles including cargo carrying vehicles and passenger vehicles.

Potential Commercial Applications: TRADS-UAS is applicable to all fixed-wing unmanned air vehicles, as well as emerging designs (e.g., eVTOL aircraft) with wing-borne flight modes. Barron is adapting the technology to thrust-borne flight modes seen in many emerging eVTOL aircraft designs. At high levels, turbulence poses safety hazards to air vehicles due to structural failure and loss of control. At lower levels turbulence contributes to excess wear and hence increased maintenance costs and reduced aircraft availability. In addition to numerous military applications, a broad range of civilian applications exist, particularly for emerging Advanced Air Mobility vehicles.

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