Topic: N181-017

Systems Technology, Inc.

Real-time Turbulence Recognition and Reporting System for Unmanned Systems
Encountering atmospheric turbulence is ubiquitous for all aircraft. With the proliferation of Unmanned Aircraft Systems (UAS) in the Navy, detection and recognition of turbulence severity must be performed by means other than an onboard pilot. Our software-based solution, Systematic Turbulence Recognition and Estimation Algorithm with Metrics (STREAM), leverages onboard sensors to estimate the intensity of aircraft turbulence, which is then displayed in real-time to ground station personnel. The algorithm has been verified with test data of multiple UAS. Systems Technology, Inc. has addressed problems facing UAS over its 60-year history through handling qualities assessments, system identification methods, and metric development and display. Our goal is to transition this technology by integrating STREAM into Navy platforms, such as the MQ-25, as well as prime contractor platforms.

Technology Category Alignment:

Air Platforms
Autonomy
Air Platforms

Contact:
David Klyde
dklyde@systemstech.com
(310) 679-2281127
https://www.systemstech.com/
SYSCOM: NAVAIR
Contract: N68335-19-C-0433
Corporate Brochure: https://navystp.com/vtm/open_file?type=brochure&id=N68335-19-C-0433

Department of the Navy SBIR/STTR Transition Program

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NAVAIR 2020-727

Topic # N181-017

Real-time Turbulence Recognition and Reporting System for Unmanned Systems

Systems Technology, Inc.

WHO

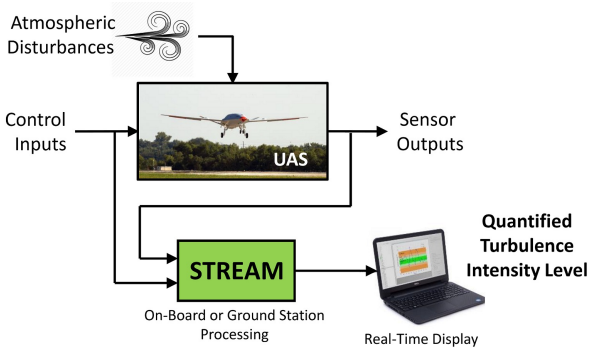
SYSCOM: NAVAIR

Sponsoring Program: PMA-262 Persistent Maritime Unmanned Aircraft Systems

Transition Target: MQ-25 Stingray (PMA-268, Unmanned Carrier Aviation)

TPOC:
(301)995-2038

Other transition opportunities: MQ-4C Triton, MQ-9 Reaper, RQ-21A Blackjack, Global Hawk



Copyright 2020 Systems Technology, Inc.; MQ-25 Navy Image courtesy of The Boeing Co/Released

Notes: The diagram shows how Systematic Turbulence Recognition and Estimation Algorithm with Metrics (STREAM) incorporates control inputs and unmanned aircraft systems (UAS) sensor outputs with atmospheric disturbances embedded in those signals to quantify the turbulence intensity level experienced by the UAS and presents this information in real-time to the ground operator to increase situational awareness and decision-making ability.

WHAT

Operational Need and Improvement: The U.S. Navy seeks to improve unmanned aircraft mission success and recovery in unknown and potentially turbulent atmospheric conditions by developing a system to recognize and quantify turbulence severity levels using aircraft sensor data (e.g., rate/acceleration gyros) in real-time. On manned aircraft, this recognition is made by the seat-of-the-pants feel of the pilot. There is currently no equivalent in UAS. STREAM serves to fill this void and provide turbulence intensity estimates in lieu of an onboard pilot.

Specifications Required: A real-time turbulence recognition and reporting system comprised of:
- On-vehicle system with an open architecture and low computational overhead
- Common existing sensors
- Minimal impact on Size, Weight, and Power (SWaP)
- Ability to be implemented on as many Navy UAS platforms as possible
- Support relevant ranges of atmospheric turbulence conditions

* Turbulence output by the system should:
- Correlate with existing maritime and aircraft forecast products (e.g., MIL-STD-1797)
- Correlate with pilot reports in aircraft in the same geographic area
- Account for specific aircraft characteristics to generate safety-critical turbulence information
- Precision, data rate, latency, and reliability

Technology Developed: Systems Technology, Inc. (STI) has developed STREAM, an algorithm that leverages native onboard sensors to estimate the presence and intensity of aircraft turbulence experienced by UAS. STREAM is a low computational overhead, frequency domain-based algorithm that is generalized and flexible, estimating multiple turbulence intensities. Moreover, STREAM can accurately estimate the turbulence intensity in the presence of additional aircraft control inputs. These estimates are then displayed in real-time to ground station personnel to increase situational awareness and inform decision-making.

Warfighter Value: STREAM will improve safety and reduce operator workload, facilitate better-informed decision making, and decrease loss of aircraft due to high turbulence levels.

WHEN

Contract Number: N68335-19-C-0433 **Ending on:** June 27, 2022

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Flight test with algorithms post-processing data	Med	b. Successful algorithm execution using platform-native sensors	4	August 2020
Hardware-in-the-loop testing	Med	Successful algorithm execution with no clock overruns and no desegregation of precision due to hardware	4	March 2021
Flight test with real-time turbulence recognition displayed on ground station	Med	Successful recognition of artificially injected atmospheric disturbances within performance constraints	5	June 2021
Generalization of STREAM and extension to rotary-wing flight	Low	Simulation validating rotary-wing turbulence recognition performance	6	June 2022
Flight test with Navy UAS experiencing atmospheric conditions prone to producing turbulence	Low	Successful recognition of turbulence intensities predicted by predicted atmospheric conditions	7	June 2023

HOW

Projected Business Model: STI has received multiple letters of interest from primes seeking a complete turbulence recognition and reporting solution. Given this existing interest, STI plans to license our solution to primes for integration into their platforms. In addition, STI has established an alliance with a small business that is developing advanced flight control hardware and software architectures that are well-suited for this application, which will be leveraged to market our technology to the small UAS commercial market place.

Company Objectives: With a 60+ year history, STI is an industry leader in the design, analysis, and testing/evaluation of manual and automatic flight control systems and related technologies. The company objectives for the Forum for SBIR Transition event are to enhance visibility for the emerging STREAM technology beyond NAVAIR to the fleet, in general, and the UAS PMAs, in particular, such that a Phase III commercialization pathway can be identified and pursued.

Potential Commercial Applications: Beyond the application of Navy fixed-wing UAS, the algorithm developed has application to UAS across military UAS as well as commercial UAS operating in any atmospheric conditions beyond calm, still air. This is a rapidly growing industry with the proliferation of emerging UAS applications including filming, infrastructure inspection, environmental and agricultural monitoring, package delivery, and urban air mobility. STREAM will serve to increase situational awareness of the operators of the inherently uncertain atmospheric conditions in these uncertain operational environments, providing an additional layer of safety and reliability that will be a key enabler for integrating these platforms into these new environments.

Contact: David Klyde, Vice President and Technical Director, Engineering Services
dklyde@systemstech.com (310) 679-2281 ext 127