Department of the Navy SBIR/STTR Transition Program

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NAVAIR 2019-760

Topic # N162-098
Aircraft Deck Motion Compensation Design
Systems Technology, Inc.

WHO

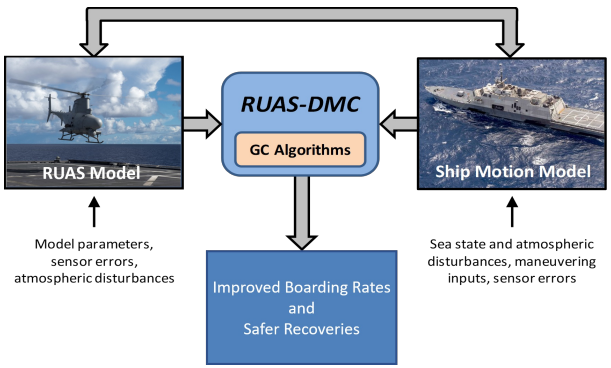
SYSCOM: NAVAIR

Sponsoring Program: PMA-268 Unmanned Carrier Aviation

Transition Target: MQ-8C Fire Scout (PMA-266, Multi-Mission Tactical Unmanned Aerial Systems)

TPOC:
(301)995-2038

Other transition opportunities:
MQ-25 Stingray



Notes:
The following diagram shows how the inherently coupled dynamics between a rotorcraft unmanned aerial system, the boarding ship, and the guidance and control (GC) algorithms are incorporated by the rotorcraft unmanned aerial system deck motion compensation (RUAS-DMC) to create a system that improves success and safety of ship boarding.

DMC: Deck Motion Compensation

WHAT

Operational Need and Improvement: The U.S. Navy wants to improve unmanned aircraft recovery rates in high sea states by developing enhanced deck motion compensation algorithms and control law design methodology & guidance utilizing airborne and/or shipboard sensors (e.g. GPS and rate/acceleration gyros).

Specifications Required:
* Performance guidance and DMC control algorithms need to be created that account for:
  - Sensitivities to sensor accuracy
  - Precision, data rate, latency, and reliability
  - Deck motion measurements and prediction methods
  - Sensor noise and errors
* Environments need to incorporate variations in ship deck:
  - Landing/recovery location and motion
  - Environmental disturbances (turbulence, ship airwake)
  - Sensor errors/noise
* A design guidance and conceptual analysis toolset that demonstrates six-degree-of-freedom simulation response of an aircraft during shipboard recovery operations

Technology Developed: STI has developed the Rotorcraft Unmanned Aerial System Deck Motion Compensation (RUAS-DMC) system to provide improved ship motion estimation and compensation approaches and will integrate with any autonomous system controller to enhance boarding rates. Our modular solution provides a completely general framework with applicability to rotorcraft and fixed wing UAS operations. The system involves two primary components: 1) a predictive deck motion estimation (DME) algorithm and 2) a swappable guidance and control (GC) algorithm.

Warfighter Value:
Will improve safety and reduce operator workload
Increase boarding rates and enhance safety with RUAS recovery operations

WHEN

Contract Number: N68335-18-C-0092 **Ending on:** October 7, 2021

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Hardware-in-the-loop testing	High	Successful algorithm execution with no clock overruns and no desegregation of precision due to hardware.	4	August 2019
Flight test with RUAS landing on virtual ship	Med	RUAS lands on virtual ship without violating any performance constraints both on hardware and with physical vehicle.	5	February 2020
Flight test with RUAS landing on physical ship	High	Successful landing within desired impact tolerances utilizing varying GC algorithms.	6	August 2020
Generalization of RUAS-DMC and extension to fixed wing flight	Med	Simulation validating fixed wing vehicle performance	6	September 2021

HOW

Projected Business Model: STI has received multiple letters of interest from primes seeking a complete Deck Motion Compensation (DMC) 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 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 RUAS-DMC technology beyond NAVAIR to the fleet, in general, and the UAS PMA's, in particular, such that a Phase III commercialization pathway can be identified and pursued. To demonstrate the capabilities of the system, a real-time simulation will be available to Forum attendees that will allow "RUAS operators" to safely recover a RUAS on a representative destroyer under high sea state conditions.

Potential Commercial Applications:
Beyond the application of air vehicles that are required to perform shipboard landings, the algorithms developed have application to commercial platforms performing landings in varying dynamic environments including the boarding of ground vehicles and landing in high wind conditions. Given that many commercial UAS and RUAS are saturating the market to provide SA and perform surveillance tasks out at sea and in the field, providing the capability to safely and reliably recover vehicles will be a key enabler for these new platforms.

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