Department of the Navy SBIR/STTR Transition Program

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NAVAIR 2017-672

Topic # N15A-T009

High Fidelity Rotorcraft Towing Modeling and Simulation with Towed Magnetic Anomaly Detection System

Advanced Rotorcraft Technology, Inc.

WHO

SYSCOM: NAVAIR

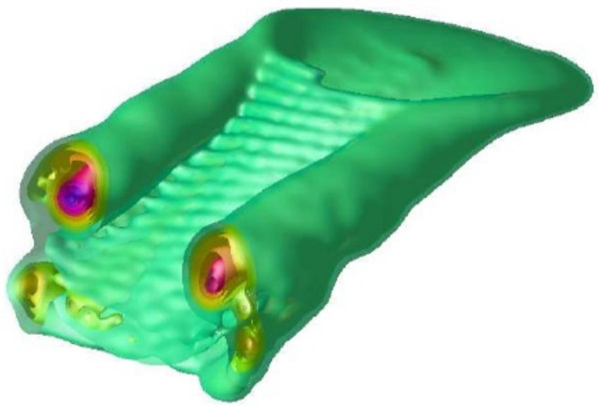
Sponsoring Program: Air Anti-Submarine Warfare Systems Program Office (PMA-264)

Transition Target: MQ-8 Fire Scout

TPOC:
(301)757-5725

Other transition opportunities: Towed Magnetic Anomaly Detection (MAD) sensor integration, simulation and analysis is of high interest for both fixed and rotary wing platforms, including unmanned aircraft systems (UAS).

Notes: The image shows an example output of the rotor wake prediction from ART's state-of-the-art viscous vortex particle method used for determining keep-out zones for light towed bodies.



WHAT

Operational Need and Improvement: Towing of a Magnetic Anomaly Detection (MAD) system is an important aspect of rotorcraft maritime operation. The rotorcraft wake effects combined with the long and flexible towing cable, the low mass ratio of the towed body to the towing aircraft, and rotorcraft vibrations transferred to the towed body present challenges for the integration of a modern MAD systems. The Navy needs a high fidelity coupled rotorcraft and towing system simulation methodology to support the design of a stable towed body to carry modern MAD sensors.

Specifications Required: The MAD sensor requires stable flight in order to reduce the motion generated magnetic noise and thus maximize the detection range. Vertical and pendulum motions, changes of attitudes, and vibrations of the tow body in the Earth's field are sources of magnetic noise. This noise is a major issue for today's magnetometers. The stability goal of the towed body, when the towing aircraft is straight and level at constant airspeed, is to maintain attitude within 0.5 degrees and altitude changes to less than 1 foot. Second order effects, such as strum on the cable and helicopter vibrations telegraphing down the cable, should also be investigated and modeled.

Technology Developed: ART is developing a high fidelity coupled rotorcraft and towing system simulation methodology to support the design of a stable towed body to carry MAD sensors. The integration goal is to maintain a stable towed body attitude and altitude change as required for the towing. The simulation tool accurately models the towing system to satisfy both towing stability and safety as required for the towing operation. The adverse effects of the rotor wash near the aircraft and cable dynamics are modeled and simulated and adverse vibratory effects are captured.

Warfighter Value: This towing simulation for MAD systems enables the analysis of various towed bodies and sensors in terms of overall performance prior to flight testing.This accelerates development and enhancement of MAD systems making them more cost effective. The towing simulation and the towing body aerodynamics database are expandable to include any manned or unmanned rotary or fixed wing aircraft.

WHEN

Contract Number: N68335-16-C-0269 **Ending on:** August 31, 2018

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Wind tunnel testing and data generation	Low	Data quality and repeatability	3	July 2017
Towed body flight testing	High	Data quality and repeatablility	3	August 2017
Computational fluid dynamics (CFD) modeling, analysis, and validation	Low	Validation with wind tunnel measurements	3	September 2017
Towing simulation validation	Med	Agreement of predicted and simulated flight data	4	June 2018

HOW

Projected Business Model: Flight with a towed external body is a unique capability of aircraft and supports a broad range of flight missions and applications. The high fidelity and efficient towing simulation in combination with ART's state-of-the-art viscous vortex particle method for aerodynamic interference will be integrated with ART's flight simulation software (FLIGHTLAB) for expanded capabilities for comprehensive vertical take-off and landing (VTOL) aircraft simulation. This will lead to opportunities including (1) consulting work on advanced future vertical lift designs, existing aircraft upgrade, safe sling load/towing operations; (2) increased FLIGHTLAB product sales with enhanced pilot (or hardware)-in-the-loop real time full flight simulation and engineering analysis, such as high fidelity simulation models and software licenses.

Company Objectives: ART aims to expand the user base to commercial research, manufacturers, and users of UAS for the entire range of drone applications. The selectable fidelity, large variety of modeling options, and proven accuracy of FLIGHTLAB flight dynamics models are well suited for simulation and analysis of small and mid-size drones and any aircraft configuration. ART's FLIGHTLAB simulation environment will be expanded to support the development of highly stable towed body systems that can, in addition to the initial intend, be used for hosts of electric and optical sensors including video camera systems.

Potential Commercial Applications: Applications include development, analysis, and testing of real estate, industrial, and oceanic towed survey platforms that require a stable flight characteristics and separation from the towing aircraft. In addition, the FLIGHTLAB simulation development system can be used for the design, optimization, and continued improvement of manned and UAS and supports all current hybrid (fixed and rotary wing) electric aircraft configurations. Complex aerodynamic interactions of rotors and aerodynamic surfaces can be investigated in computational time and efforts order of magnitude lower than common CFD simulation.

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