Topic: N15A-T002

Kord Technologies, Inc.

Vortex Preserving and Consistent Large Eddy Simulations for Naval Applications
Temporal loads resulting from wind eddies on aerial vehicles during flight-deck launch and recovery cannot be accurately estimated from current flight test data. To better predict these loads and enhance operations, our simulation tools provide software components for computationally efficient but accurate prediction of disparate scale turbulence interactions. The resulting digital-simulator allows the coarser mesh use without the undesired excessive dissipation and grid-dependency, resulting in an enhanced cost-effective predictive simulation. Kord specializes in aerospace and defense technology software/hardware prototyping, including the DoD simulation tools: Kestrel and Helios. The system has been successfully integrated in naval relevant applications. Our goal is to integrate and transition this technology to DoD acquisition tools and pilot training simulators as well as adoption to the commercial sector.

Technology Category Alignment:

Electronics Integration
Test, Evaluation, Validation, and Verification
Advanced Computing/Software Development
Conceptual, Computational, and World-Wide Environmental Representation
Simulation Information Technology

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SYSCOM: NAVAIR
Contract: N68335-17-C-0159
Corporate Brochure: https://navystp.com/vtm/open_file?type=brochure&id=N68335-17-C-0159

Department of the Navy SBIR/STTR Transition Program

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NAVAIR 2018-783

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Vortex Preserving and Consistent Large Eddy Simulations for Naval Applications

Kord Technologies, Inc.

WHO

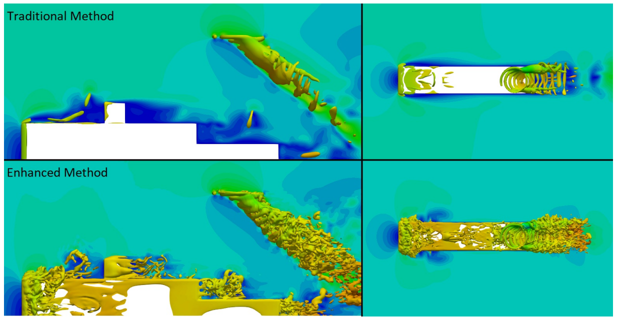
SYSCOM: NAVAIR

Sponsoring Program: Naval Air Warfare Center Aircraft Division (NAWCAD)

Transition Target: PEO(A)

TPOC:
(301)342-8548

Other transition opportunities:
NAWCAD IBST (Integrated Battlespace Simulation and Test), Pax River, and Training Systems Division, Orlando



Notes: Existing compressible and incompressible CFD technologies include a form of artificial dissipation or numerical dissipation for stability purposes. In addition, commonly used turbulence models add a significant amount of dissipation in their formulation. This dissipation compounds on top of physical dissipation due to turbulence transport and consequently causes larger unphysical dissipation. This deficiency leads to inadequate simulations and results for transient phenomena such as rotorcraft. Our methods maintain stability while reducing artificial dissipation to preserve vorticity and utilize a physical turbulence model to model dissipation to effectively simulate turbulence and consequently system performance.

Image depicts a snapshot of a 3D Computational Fluid Dynamic (CFD) simulation of a rotorcraft-ship airwake using traditional methods (top) and our enhanced methods (bottom). Contours are colored by Mach number and vorticity iso-surfaces are colored by pressure.

WHAT

Operational Need and Improvement: Highly unsteady vorticity-dominated turbulent flows are significant drivers of aircraft performance; moreover, operating in the naval environment adds additional complexities that are truly unique and directly impact safety and mission success. For example, approaching and landing on the back of a pitching and heaving small-deck ship is one the most challenging tasks faced by rotary-wing naval aviators. The interaction of this ship airwake with the approaching aircraft directly impacts aircraft aeromechanics through complicated fluid dynamics and fluid-structural dynamics interactions. Recent advancements in Computational Fluid Dynamics (CFD) have demonstrated their ability to predict rotorcraft and ship airwakes independently. Due to the vastly different time and length scales, predicting fully-resolved rotorcraft-ship airwake interactions using these existing CFD methods will be unlikely for many years to come without major relaxation of the mesh resolution requirement.

Specifications Required: Innovative turbulence models for addressing these disparate length scales and maintaining the necessary accuracy and computational efficiency are desired.

Technology Developed: We have developed state of the art vorticity preserving and turbulence models that accurately and effectively simulate turbulence using existing computational resources. The method counteracts artificial dissipation in areas where it is not necessary and instead utilizes a physics-based turbulence model to model turbulence decay. In addition, the formulation is grid spacing independent which allows for grid refinement studies to be performed (i.e. as grid is refined, simulation converges to a solution).

Warfighter Value: The technology combined with existing CFD tools can be used to enhance, accelerate, and reduce the costs of development, analysis, and upkeep of current and next generation rotorcraft. The module simulates turbulence more accurately which in turn leads to higher accuracy and better prediction of temporal loads on the vehicles. Our models enable coarser and computationally cheaper simulations to have higher accuracy than before which will speed up time to solution for analysis. The module already interfaces with DoD CREATE-AV Kestrel and Helios CFD platforms currently in use by many DoD employees and contractors. In addition, the module can be integrated into existing flight simulators to train current and future personnel in more realistic rotorcraft-ship scenarios.

WHEN

Contract Number: N68335-17-C-0159 **Ending on:** December 31, 1969

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Proof of concept in canonical cases	Med	Physically sound theory and analysis. Successful validation compared to literature/experiments on canonical cases of vortex interactions.	4	June 2017
Applied to rotorcraft relevant cases	Low	Application of the turbulence models in rotors and rotorcraft-ship airwake interactions using prototype research code. Successful validation compared to literature/experiments.	5	December 2017
Module development	Low	Correct, usable, and fast algorithms that can be incorporated easily into existing CFD solvers. Successful validation and verification of methods on previous cases.	5	September 2018
Integration into DoD CFD solvers	Med	Successful incorporation of the module into DoD CREATE-AV Kestrel and Helios CFD platforms. Successful verification and validation based on previous results.	6	December 2018
Test on system prototype	Low	Testing of the module using Kestrel and Helios on a more realistic scenario of rotorcraft-ship airwake interaction	7	June 2019

HOW

Projected Business Model: Our business model is to market software licenses and engineering services to the Government and Primes. Software licenses of the module for Kestrel and Helios are available for Primes who wish to utilize our enhanced methods. We can also implement the methods directly into existing customer software through consulting. In addition, we offer engineering consulting in the form of running simulations and performing analysis of vehicles and scenarios for design and development purposes.

Company Objectives: As computational resources become faster, more abundant, and more parallel, accurate simulations of complex vehicles are starting to become more prevalent in their design and analysis. We envision the technology being used to increase simulation fidelity to further enable this trend for next generation vehicles. We anticipate the Navy Forum for SBIR/STTR Transition (FST) will facilitate connections with Government and industry decision-makers that seek to improve the use of computational simulations in their design and analysis process for aerial vehicles. Our short-term plans are to integrate our innovative turbulence model into other existing CFD solvers.

Potential Commercial Applications: The technology would be applicable and useful for other complex wake interactions. Improvement to CFD solvers resulting from the work would be applicable to interactions ranging from wind gust interactions between city buildings to the complex flow field emanating from the nose of a race car and interacting with the rear wing. The method can also improve weather forecasting simulations. Anything that CFD is used in problems involving vortex or circulation dominated flows could benefit from this work.

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