HIGH PERFORMANCE COMPUTING MODERNIZATION PROGRAM RESEARCH PROJECT #: HPCMP-HIP-25-027

CREATE-AV Helios Flow Solver Development and Validation

About CCDC AvMC:

Technology Development Directorate (TDD) is the rotorcraft aeromechanics research branch under the U.S. Army Combat Capabilities Development Command (CCDC). TDD is home to researchers, scientists and engineers who are working to execute critical technology discovery and development programs, including Future Vertical Lift. The center is located at the NASA Ames Research Center and is a leading research group in the field of rotorcraft aeromechanics.

RESEARCH LOCATION: Moffett Field, CA

PROJECT DESCRIPTION:

This project will contribute to ongoing development and validation of Helios flow solver modules (RAPIDUS/G3D) as well as 3-D finite element structural dynamics solver X3D.

The intern activities will focus on development and testing of new flow solvers within Helios and assessment of advanced capabilities on problems of interest to the Army FVL program. Past experience has shown that interns using Helios can pick up the code within a week or two and complete CFD/CSD calculations relevant to both the Army TDD organization as well as to their graduate studies.

The proposed summer intern projects will all use state-of-the-art high-fidelity CREATE modeling and simulation software tools. The projects involve the investigation of real-life practical engineering problems that are important to the mission of our Army laboratory. Student interns will share offices with and collaborate directly with our Army senior technical staff. The students will be challenged to solve real DoD engineering problems with results that could potentially result in technical conference papers.

We are seeking three interns for this project, with each assigned to development, testing and validation of a particular flow solver within Helios. Helios developers will make mini-applications available to the interns to facilitate testing and development of fundamental algorithms. For actual validations, interns will get trained and utilize the full CREATE-AV Helios simulation suite. The three areas we seek interns are:

1). Research with X3D, the state-of-the-art three-dimensional finite element analysis solver for rotor dynamics. The X3D solver has only recently been released to other government and industry members, and even so only to select entities. The X3D solver requires a different workflow than traditional beambased codes used in rotorcraft dynamics, and several tools have been released with X3D to help with user accessibility. The goal of this effort will be to test and help improve the X3D workflow.

2). Explore accuracy of various gradient reconstruction schemes in the context of our new unstructured flow solver (RAPIDUS) and promote discovery of numerical methodologies that can yield improved accuracy and robustness in the context of unstructured grid based solutions to partial differential equations.

3). Evaluate G3D, a performance portable compressible flow solver designed for structured curvilinear grids that will be used in Helios. Depending on intern interests/experience, intern will explore improved numerical algorithms, solver capabilities, and optimizing code performance in a mini-application, or complete CFD validation cases using G3D.

ANTICIPATED START DATE:

June 2025 – Exact start dates will be determined at the time of selection and in coordination with the selected candidate.

QUALIFICATIONS:

The ideal candidate should be junior or senior level undergraduates, graduate program, post master's or post-doctoral program in Aerospace/Mechanical Engineering, Computer Science, Applied Mathematics, or another STEM related field with emphasis on modeling and simulation. A background in the field of rotary wings is preferred but not essential. Familiarity with Fortran 90, C/C++ & Python is useful. Familiarity with GPU computing is a plus. Prior software development experience is favorable. Good mathematical background with understanding of numerical solution to PDE's is expected.

ACADEMIC LEVEL:

Degree received within the last 60 months or currently pursuing:

- Bachelor's
- Master's
- Doctoral

DISCIPLINE NEEDED:

- Computer, Information, and Data Sciences
- Mathematics and Statistics
- Engineering
- Science & Engineering-related