HIGH PERFORMANCE COMPUTING MODERNIZATION PROGRAM

RESEARCH PROJECT #: HPCMP-HIP-25-041

High Fidelity Aerodynamic Simulations of Gas Turbine Engine Compression Systems

About NAWCAD:

The Naval Air Warfare Center Aircraft Division is part of Naval Air Systems Command (https://www.navair.navy.mil/nawcad). NAWCAD scientists and engineers provide the technical excellence to support the maritime engineering needs related to technology development, system acquisition, and product support of all naval aviation engineering. NAWCAD operates propulsion and power facilities that conduct testing of propulsion systems and the components of all naval aircraft systems in addition to systems of other services and research agencies. The CFD and Noise Branch is within the Propulsion and Power Department within NAWCAD.

RESEARCH LOCATION: Patuxent River, MD

PROJECT DESCRIPTION:

The project will focus on developing simulations of a complex full-wheel compressor system to research the ability of wall-modeled large eddy simulation to accurately predict this flow field at design and off-design conditions.

The goals of this project are to develop a validated simulation on a centrifugal compressor that can be used to complement parallel simulations of active program office projects. The Fidelity CharLES flow solver will be used for carrying out the large-eddy simulations in this study. The governing equations employed are the time-dependent, compressible, filtered Navier-Stokes equations. CharLES utilizes central difference fluxes with a blended upwind scheme that is focused on the conservation of kinetic energy and entropy which results in a highly accurate, low-dissipation scheme. CharLES can be employed on either CPU or GPU architectures, with a mixed precision algorithm employed to optimally leverage the GPUs.

The project will initially focus on the intern training through a series of tutorials and hands on discussions with the mentor and branch to understand the entire simulation workflow for high fidelity turbomachinery predictions. In the second half of the project, the intern will develop a series of meshes on the turbomachinery geometry, run the simulations, and analyze the results to compare against measurement data with assistance from the mentor.

The intern will collaborate with a team of researchers in the NAWCAD Propulsion and Power department. They will focus on developing simulations of a complex full-wheel compressor system to research the ability of wall-modeled large eddy simulation to accurately predict this flow field at design and off-design conditions. The intern will develop the entire simulation as well as post-processing to analyze the outcomes. The intern will collaborate with other researchers in the branch working similar parallel efforts on fleet aviation challenges.

The NAVAIR is the center of Naval Aviation, acquisition, and test. While on base, the airspace is always busy with a number of different aircraft and test platforms. There are frequent hangar tours available to employees and interns for a number of helicopter and fighter platforms. Propulsion and Power also included the Propulsion test facilities for a number of engine and rotor test cells.

The desire for the intern at the completion of the summer, is to understand the assumptions for high fidelity modeling of compressor systems and to evaluate the accuracy for this specific problem. The intern will be utilizing state of the art physic-based modeling software on DoD HPCMP GPU accelerated systems.

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 will be an engineering student pursuing a master's or doctoral with preferences towards a graduate school focus on propulsion related compressible flow. Desired backgrounds can be experimental or numerical, with focuses ranging from fluid dynamics, turbomachinery, heat transfer, combustion, hypersonic, and acoustics.

Using engineering design and analysis tools such as CAD programs and Matlab is preferred. Using CFD software is preferred but not required. Proficient knowledge and use of high performance computing systems and Linux command line, bash, and scripting environments is preferred.

ACADEMIC LEVEL:

Degree received within the last 60 months or currently pursuing:

- Bachelor's
- Master's
- Doctoral

DISCIPLINE NEEDED:

- Engineering
- Science & Engineering-related