HIGH PERFORMANCE COMPUTING MODERNIZATION PROGRAM

RESEARCH PROJECT #: HPCMP-HIP-25-006

High-Fidelity External-Internal Aerodynamic Modeling on Airbreathing Hypersonic Vehicles

About DEVCOM ARL:

The DEVCOM Army Research Laboratory (ARL) is the Army's sole foundational research laboratory strategically placed under the Army Futures Command. ARL focuses on cutting-edge scientific discovery, technological innovation, and transition of knowledge products that offer incredible potential to improve the Army's chances of surviving and winning any future conflicts. The ARL Flight Sciences Branch, located at Aberdeen Proving Ground (APG), MD, studies the flight of guided Army munitions. The branch accomplishes this through Computational Fluid Dynamics (CFD) using DoD HPCMP HPC resources, and through experimentation at the ARL Transonic Experimental Facility at APG, the world's largest free-flight spark shadowgraph range.

RESEARCH LOCATION: Aberdeen Proving Ground, MD

PROJECT DESCRIPTION:

The intern will gain knowledge and experience by collaborating with a team of scientists and engineers in:

- Improving our understanding of the complex flow physics of high-speed airbreathing flight vehicles. Steady-state and transient simulations will be employed to accurately characterize external and internal aerothermodynamics. Specifically, high fidelity Navier-Stokes Computational Fluid Dynamics (CFD) simulations that couple the external flow field with internal turbulent combustion in a scramjet engine of a hypersonic flight vehicle will be performed. This research will improve our scientific understanding of flow phenomena to manage extreme aerothermodynamic loadings and accelerate optimal design of next generation Army hypersonic weapons.

- Advancing the modeling of a hypersonic weapon vehicles, enhancing the operational capabilities for the Army and DoD. Through Navier-Stokes CFD, the interaction of shock waves with boundary layers over DoD-relevant weapon vehicles and their effect on aerodynamic propulsion combustion will be investigated. A key focus of the research will be the interaction between external flow field and the internal inlet and combustion modeling. Parameters to be studied include angle of attack, enthalpy effects, vibrational and chemical non-equilibrium effects, and unsteadiness. HPC tools and resources, (e.g., Secure Remote Desktop, DoD Supercomputing Resources Centers) will be leveraged to generate computational meshes, perform CFD simulations and post process analyses.

- High-fidelity, HPC CFD analyses will be undertaken of high-speed weapon vehicles. The intern will leverage HPCMP resources to generate computational meshes, perform CFD simulations to investigate high-speed aerodynamics, gas-flow chemistry effects under various Mach numbers, angle of attack, and high enthalpy conditions. The intern will be involved in collecting and analyzing data from these simulations, contributing to the validation of models using DoD experimental data. They will collaborate with research teams to interpret results and refine models, gaining valuable insights into the complexities of hypersonic vehicle performance. In addition to technical activities, the intern will have opportunities for professional development. They will participate in networking activities with experts in the field of hypersonic and propulsion, as well as attend technical meetings with existing collaborations with nation-leading academic researchers in hypersonic aerothermodynamics

ANTICIPATED START DATE:

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

QUALIFICATIONS:

Prospective candidates should have a passion in fluid dynamics and have experience performing computational fluid dynamics. Candidates with a bachelor's in aerospace engineering or mechanical engineering with a focus in fluid mechanics are preferred. Candidates should have a fundamental skill set in Unix. Additionally, the ideal candidate should demonstrate proficiency in analyzing and interpreting experimental data, as well as the ability to apply theoretical knowledge to practical problems. Strong problem-solving skills, attention to detail, and the ability to research effectively in a collaborative research setting are essential. Experience in hypersonic research will be considered favorable.

ACADEMIC LEVEL:

Degree received within the last 60 months or currently pursuing:

- Bachelor's
- Master's
- Doctoral

DISCIPLINE NEEDED:

- Computer, Information, and Data Science
- Engineering
- Science & Engineering-related