Rotor Aerodynamics and Structural Loads for a Coaxial Rotor Test Stand

About DEVCOM ARL:

The DEVCOM Army Research Laboratory conducts basic and applied research for the Army. Its mission is to operationalize science for transformational overmatch. The basic research conducted at the laboratory leads to capabilities for soldiers to fight and win on the battlefield. The Vehicle Applied Research Branch specifically conducts experimental and computational research in rotary-wing and other vertical lift technologies at both the manned and unmanned scales.

RESEARCH LOCATION: Aberdeen Proving Ground, MD

PROJECT DESCRIPTION:

This project will continue the research conducted in the prior year internship on a coaxial rotor test stand. Coaxial rotor aircraft have been proposed for future vertical lift applications. Both lift-offset coaxial rotors and more conventional coaxial rotors have potential for high maneuverability and high speed for future aircraft. There are a number of technology risks and uncertainties related to coaxial rotor aerodynamics, vibration, and loads, especially at high speed. The DEVCOM Army Research Laboratory is in the process of designing a coaxial rotor test bed for wind-tunnel testing. The intern project will conduct CFD and coupled CFD/CSD analysis of the wind tunnel model design using DoD products RCAS and Helios and predict its performance, loads, and vibration.

The scientific objectives of the project are to develop comprehensive analysis and CFD models of a coaxial rotor wind tunnel model and use these models to estimate performance, vibration, and loads on the model at a number of flight conditions and investigate the effect of blade index angle on blade and hub loads. This is a continuation of a previous project, and some meshes, and models already exist. The comprehensive analysis model the student will use is the Rotorcraft Comprehensive analysis system (RCAS), and the CFD software is the CREATE-AV product Helios. The intern will also use the CREATE-FT Capstone meshing software or commercial software to create CFD meshes. RCAS will calculate control settings to trim the rotors and the resulting loads, vibration, and linearized stability. The interactions of the closely spaced rotors will require high-fidelity aerodynamics for accurate predictions. RCAS is coupled to Helios to provide high-fidelity aerodynamics. The student will develop post-processing scripts to extract structural quantities of interest from RCAS and aerodynamic quantities from Helios.

The intern will be given the opportunity to conduct research in an Army-relevant program using state-of-the art computational tools Helios and the Army's Rotorcraft Comprehensive Analysis System (RCAS), and Capstone. Normally the CREATE program offers a training class on Helios and Capstone at the beginning of summer that summer students from several DoD laboratories attend. The mentors will train the student to use RCAS, to create CFD/CSD coupled models in Helios, and to develop custom scripts to post-process the Helios results. The student would use models of a coaxial rotor wind tunnel model and the XH-59 Advancing Blade Concept aircraft. Normally the intern requires significant training with RCAS models, and this provides an opportunity for the student to learn a widely used DoD analysis tool.

In past years, as a result of their internships, interns have learned to use a number of government-owned computational tools which they would not have access to at school, which makes them more interested in and marketable to the DoD and aircraft companies. Many have co-authored papers and even gone on to be hired into DEVCOM ARL, hired elsewhere within the DoD or by aircraft industry companies and many have returned to ARL or interned at other Army research facilities. Exact research will depend on the intern's prior experience and interest. An approximate 10-week schedule is as follows:

Weeks 1-3: Training on software and development of CFD meshes, and RCAS models.

Weeks 4-7: Conduct most of computational runs and process results.

Weeks 8-10: Complete computational runs, prepare HIP deliverables, and participate in summer student symposium.

ANTICIPATED START DATE:

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

QUALIFICATIONS:

The ideal candidate would be master's or doctoral student in aerospace engineering with education or experience in vertical lift/rotorcraft aerodynamics and dynamics.

Favorable knowledge and experience include:

- Aerodynamics and computational fluid dynamics
- Rotorcraft dynamics
- Structural dynamics and vibration
- Scientific programming in languages such as Matlab or Python
- Experience with government software tools including RCAS, Helios, FUN3D, OVERFLOW or willingness to learn
- Experience with CFD meshing tools

ACADEMIC LEVEL:

Degree received within the last 60 months or currently pursuing:

- Master’s
- Doctoral

DISCIPLINE NEEDED:

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