Opportunity Title: Aeroballistics and Its Application to Guided and Unguided Army Munitions
Opportunity Reference Code: ARL-R-WMRD-300135

Organization
DEVCOM Army Research Laboratory
Reference Code
ARL-R-WMRD-300135
Description

About the Research

The DEVCOM Army Research Laboratory (ARL) Flight Sciences Branch (FSB) is soliciting researchers to contribute to our ongoing research in aeroballistics and its application to guided and unguided Army munitions.The project involves Aerosciences, Flight Dynamics and Control, and Range Experimentation. Aerosciences involves the study of complex flow phenomena of Army munitions across different Mach numbers and flow conditions. This includes research areas of vortex interactions, shock-boundary layer interaction, shock-shock interaction, and boundary-layer transition, turbulence, as well as coupled fields such as heat transfer and fluid-structure interaction. Our primary methods for Aerosciences research are computational models ranging in complexity from semi-empirical aero prediction models to CFD models of varying complexity. Windtunnel and free flight experiments serve to complement and validate simulation predictions.

Flight Dynamics and Control involves the study of the response of a munition to aerodynamic forces and moments, and how to control them to increase range, evade counter-fire, and to hit targets with high accuracy. For unguided flight, research involves detailed study of stability, drag, and delivery errors related to fire control, aim, jump, and dispersion. For guided flight, research involves control actuation systems (CASs) that drive maneuver surfaces such as fins and canards. Maneuver research also involves rocket techniques such as thrust vectoring. This also involves research in control algorithms (such as adaptive control or model predictive control) to reliably maneuver Army projectiles to the target despite limited state information, control authority, and changing flight environments. Flight Dynamics and Control research makes significant usages of 6-DOF guided flight models to connect together component flight, control, and sensor models and understand their performance as a system. Hardware-in-the loop (HIL) is used to study prototype CASs, developmental control algorithms, and their ability to provide the required maneuvers throughout the flight envelope. Coupled CFD/RBD models are used to understand the flight of complex projectiles, particularly in cases of unsteady flow conditions.

Range Experimentation involves the study of munition flight and structural integrity as it leaves the gun/launcher and throughout the planned trajectory. This involves fabrication of prototype munitions with required sensors, electronics, and CASs. It also involves collaboration with propulsion researchers to implement a method of propulsion. Projectile integrity is studied through shock experiments, muzzle x-ray, and soft-catch techniques. Flight performance is studied through a combination of spark shadography, high-speed video, radar, onboard sensors, and yaw cards, and is post-processed using novel system identification techniques to estimate aerodynamic parameters. Range Experimentation also involves a continuous process of maintaining and improving range instrumentation as well as expanding experimental capabilities by developing new techniques, equipment, and facilities.

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Keywords: Aerosciences, Flight Dynamics and Control, Range Experimentation, Computational Fluid Dynamics, Control Actuation System, Flight Control, System Identification, Modeling and Simulation, Hardware-in-the-loop, Guns, Missiles

About WMRD

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The goals of the Weapons and Materials Research Directorate (WMRD) are to enhance the lethality and survivability of weapons systems, and to meet the soldier's technology needs for advanced weaponry and protection. Research is pursued in energetic materials dynamics, propulsion/flight physics, projectile warhead mechanics, terminal effects phenomena, armor/survivability technologies, environmental chemistry, and advanced materials (energetic, metals, ceramics, polymers, composite/hybrids, and mechanics) for armor, armament, missiles, ground vehicles, helicopters, and individual soldier applications necessary for maintaining and ensuring supremacy in future land warfare.

About ARL-RAP

The Army Research Laboratory Research Associateship Program (ARL-RAP) is designed to significantly increase the involvement of creative and highly trained scientists and engineers from academia and industry in scientific and technical areas of interest and relevance to the Army. Scientists and Engineers at the CCDC Army Research Laboratory (ARL) help shape and execute the Army's program for meeting the challenge of developing technologies that will support Army forces in meeting future operational needs by pursuing scientific research and technological developments in diverse fields such as: applied mathematics, atmospheric characterization, simulation and human modeling, digital/optical signal processing, nanotechnology, material science and technology, multifunctional technology, combustion processes, propulsion and flight physics, communication and networking, and computational and information sciences.

A complete application includes:

- **Curriculum Vitae or Resume**
- **Three References Forms**
  - An email with a link to the reference form will be available in Zintellect to the applicant upon completion of the on-line application. Please send this email to persons you have selected to complete a reference.
  - References should be from persons familiar with your educational and professional qualifications (include your thesis or dissertation advisor, if applicable)
- **Transcripts**
  - Transcript verifying receipt of degree must be submitted with the application. Student/unofficial copy is acceptable

If selected by an advisor the participant will also be required to write a **research proposal** to submit to the ARL-RAP review panel for :

- Research topic should relate to a specific opportunity at ARL (see Research Areas)
- The objective of the research topic should be clear and have a defined outcome
- Explain the direction you plan to pursue
- Include expected period for completing the study
- Include a brief background such as preparation and motivation for the research
- References of published efforts may be used to improve the proposal

A link to upload the proposal will be provided to the applicant once the advisor has made their selection.

Questions about this opportunity? Please email ARLFellowship@orau.org.

Eligibility Requirements

- **Citizenship:** U.S. Citizen Only

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- **Degree:** Bachelor's Degree, Master's Degree, or Doctoral Degree.
- **Academic Level(s):** Any academic level.
- **Discipline(s):**
  - **Engineering** (22)
  - **Physics** (11)
- **Age:** Must be 18 years of age