Opportunity Title: Actuation and Controls Research for Advanced Adaptive Propulsion Concepts
Opportunity Reference Code: ARL-R-WMRD-300126

Organization DEVCOM Army Research Laboratory

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Description **About the Research**

The US Army Research Laboratory, Mechanical Sciences Division under the Weapons and Materials Research Directorate performs basic and applied research on Turbine Power and Propulsion Sciences including hypersonic vehicle systems to innovate far-term and mid-term technologies envisioned for future Multi-Domain Battlefield Operations. Vehicle Power and Propulsion technologies are key thrust areas for innovations in Army rotorcraft gas turbine engines and hypersonic long-range precision fire weapon systems to enhance their efficacy of targeted lethality, durability, safety and superior performance with cost-effective sustainability. For high power density engines operating under extreme harsh operating conditions, it is important to develop advanced high temperature next-gen materials, thermal/environmental barrier coatings, and adaptive components for high-efficiency multi-domain operational capability. In the area of hypersonics research, efficiency advantages can be realized in real time, such as improving the aerodynamic efficiency, thermal loading, flight range, and maneuverability using light-weight high temperature materials and adaptive structures for better overall performance. The development of such advanced systems require tightly coupled fluid-structure interaction simulation enabled advanced vehicle concepts and better control systems. Actively changing the geometry of the aerodynamic lifting and control surfaces, enables reconfiguration of vehicle structure in real-time to optimized performance, increasing the effective lift-to-drag ratio and keeping benign thermal exposure to the hypersonic vehicle structures. Under this research program, focus will be to innovate advanced gas turbine concepts with adaptive components, morphing scramjet inlets, articulating exhaust nozzles and other morphing or articuclating structures for control surfaces or leading edge nose sections of vehicle systems. The research will involve intelligent, robust, and adaptive control and actuation methods that will advise scaling and feasibility for implementation in airbreathing engine flow paths, lifting surfaces, and control surfaces.

Prospective researchers will focus on multi-disciplinary systems-level approach to maximize the speed and accuracy while minimizing the complexity of adaptive hypersonic systems using advanced actuators, smart materials, sensor systems, and new adaptive control methods to manage the open-ended degrees of freedom of morphing systems. Methods will span both active smart-material based or conventional control and passive methods taking advantage of the natural forces and temperatures encountered in flight conditions. The research will focus on developing high-temperature smart-material based actuation systems with fail-safe closed-loop controller. Researchers will conduct full-scale and scaled-down experiments in relevant thermal and aerodynamic environments integrating inputs from the research team, providing validation data for analysis as well as correction factors accounting for unmodeled physics. The MDAO (Multi-Domain Analysis & Optimization)-

based vehicle design configurations and associated performance predictions will be established to represent the full potential of morphing technology given a fully custom design. The result will provide an experimentally characterized prototype of enabling morphing-vehicle technologies including materials and actuation systems in relevant, combined high-temperature and aerodynamic environments. This research will also characterize the parameter trade space and mission effectiveness of a suite of optimized hypersonic morphing actuation concepts using state-of-the-art, experimentally-informed MDAO processes.

This research position is a critical part of on-going mission programs towards developing next-gen propulsion technologies, including adaptive turbine component based propulsion, articulating blades, and morphing hypersonic systems for current and future Army vehicles. Research proposals are invited to conduct basic and applied research on efficient high-force density actuation systems using smart materials or devices, adaptive fail-safe control systems and thermal protection for on-board actuation systems. The candidate will have a deep knowledge of smart material based actuators, mechanisms, advanced control algorithms, and thermal protection materials/coatings. The candidate shall have capabilities to research on multi-body systems analysis and hardware-in-the-loop (HIL) experimental assessments to optimize actuation mechanisms and control schemes to innovate efficient structural morphing with quick response to control inputs. The selected candidates will research closely with ARL staff in the Weapons and Materials Research Directorate, as well as cross-directorate and other DoD agency collaborations. The nature of the research will also require establishing close interactions with simulation or experimental experts within ARL, and relevant external partners from academia, industry and other national laboratories.

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About WMRD

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

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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.

For information on how to apply, please visit the ARL-RAP website.

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

Eligibility Requirements

- **Citizenship:** U.S. Citizen Only
- **Degree:** Bachelor's Degree, Master's Degree, or Doctoral Degree.
- **Academic Level(s):** Any academic level.
- **Discipline(s):**
  - **Computer, Information, and Data Sciences** (14 👁)
  - **Engineering** (27 👁)
  - **Mathematics and Statistics** (10 👁)
  - **Physics** (16 👁)
- **Age:** Must be 18 years of age