Opportunity Title: Computational Modeling of Coupled Multiphysical Fields in Solids
Opportunity Reference Code: ARL-R-SEM-400028-F1

Organization DEVCOM Army Research Laboratory

Reference Code ARL-R-SEM-400028-F1

Description Research opportunities exist for modeling highly transient, coupled, multiphysical fields in solids using analytical, finite element, finite difference, peridynamic [1,2], phase field [3], discrete element, and other computational methods. Emphasis is placed on model validation with experiments, and verification with analytical solutions to transient coupled-field boundary value problems involving wave propagation, thermo-mechanical and electromagnetic fields in finitely deformed matter [4], fluid-structure interaction associated with shock, impact, dynamic fracture [5], and fragmentation phenomena. Additional research opportunities exist in the areas of machine learning, topology optimization [6], multiscale modeling of material microstructures using genetic programming and computational geometric methods [7] for use in conjunction with large-scale finite element and other computational solvers.

References:

[1] Gazonas GA, Aksoylu B, Wildman RA, “Fast Fourier transform-based solutions of initial value problems for wave propagation in microelastic media,” Journal of Mechanics of Materials and Structures, Vol. 19(1),61–89, 2024.

[2] Aksoylu B, Gazonas GA, “On the choice of kernel function in nonlocal wave propagation,” Journal of Peridynamics and Nonlocal Modeling, Vol. 2, 379–400, 2020.

[3] Chua J, Agrawal V, Breitzman T, Gazonas GA, Dayal K, “Phase-field modeling and peridynamics for defect dynamics, and an augmented phase-field model with viscous stresses,” Journal of the Mechanics and Physics of Solids Vol. 159, 2022.

[4] Weile DS, Hopkins DA, Gazonas GA, Powers BM, “On the proper formulation of Maxwellian electrodynamics for continuum mechanics,” Continuum Mechanics and Thermodynamics, Vol. 26, Issue: 3, 387–401, 2014.

[5] Zhang G, Gazonas GA, Bobaru F, “Supershear damage propagation and sub-Rayleigh crack growth from edge-on impact: a peridynamic analysis,” International Journal of Impact Engineering, Vol. 113, 73–87, 2018.

[6] Gaynor AT, Johnson TE, “Eliminating occluded voids in additive manufacturing design via a projection-based topology optimization scheme,” Additive Manufacturing, Vol. 33, 101149, 2020.

[7] Wildman RA, Gazonas GA, “Multiobjective topology optimization of energy absorbing materials,” Structural and Multidisciplinary Optimization, Vol. 51, 125–143, 2015.

Reports

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About ARD

ARL's Army Research Directorate (ARD) focuses on exploiting concept development, discovery, technology development, and transition of the most promising disruptive science and technology to deliver to the Army fundamentally advantageous science-based capabilities through laboratory's 11 research competencies. This intramural research directorate also manages the laboratory's essential research programs, which are flagship research efforts focused on delivering defined outcomes.

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.

About SCIENCE OF EXTREME MATERIALS (SEM)

Materials and related manufacturing methods focusing on mechanical response and performance extremes, including active, adaptive, and flexible/soft materials; novel manufacturing science for energetic materials.

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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.

Qualifications Desired Qualifications & Experiences:

• Proficiency in programming languages commonly used in high-performance computing, such as Python, C++, Fortran, et cetera.

• Familiarity with software development tools, version control systems, and high-performance computing simulation environments.

• Familiarity with the FEniCS or other open-source computing platforms for solving partial differential equations (PDEs) with the finite element method (FEM).

• Strong mathematical and analytical skills, including linear algebra, calculus, continuum mechanics, thermodynamics, finite element, peridynamic, phase-field or discrete element modeling, fracture mechanics.

• Effective written and verbal communication skills for documenting and presenting research findings.

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• Collaboration and teamwork skills, as you may work with a team of researchers or engineers.

Point of Contact ARL

Eligibility Requirements

- **Citizenship:** U.S. Citizen Only
- **Degree:** Master's Degree or Doctoral Degree.
- **Academic Level(s):** Master's Degree (Journeyman Fellow), Master's Degree 7+ years (Senior Fellow), Doctoral Degree (Postdoctoral Fellow), Doctoral Degree 5+ years (Senior Fellow), or Faculty.
- **Discipline(s):**
  - **Chemistry and Materials Sciences** (12 👁)
  - **Computer, Information, and Data Sciences** (17 👁)
  - **Earth and Geosciences** (21 👁)
  - **Engineering** (27 👁)
  - **Mathematics and Statistics** (11 👁)
  - **Physics** (16 👁)
  - **Science & Engineering-related** (2 👁)