

Opportunity Title: Energy Boost Approaches
Opportunity Reference Code: ICPD-2021-39



Organization Office of the Director of National Intelligence (ODNI)

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How to Apply

Create and release your Profile on Zintellect – Postdoctoral applicants must create an account and complete a profile in the on-line application system. **Please note: your resume/CV may not exceed 2 pages.**

Complete your application – Enter the rest of the information required for the IC Postdoc Program Research Opportunity. The application itself contains detailed instructions for each one of these components: availability, citizenship, transcripts, dissertation abstract, publication and presentation plan, and information about your Research Advisor co-applicant.

Additional information about the IC Postdoctoral Research Fellowship Program is available on the program website located at:
<https://orise.orau.gov/icpostdoc/index.html>.

If you have questions, send an email to ICPostdoc@orau.org. Please include the reference code for this opportunity in your email.

**Application
Deadline**

2/26/2021 6:00:00 PM Eastern Time Zone

Description

Research Topic Description, including Problem Statement:

Autonomous millimeter-scale robots will be a powerfully effective and low-cost tool with broad application. To be realized, however, numerous challenges must first be solved, including mobility, energy, sensing, communication, and control. Moreover, these challenges must be solved simultaneously for microrobotics to work effectively on specific problems. Microrobotics is an intensively interdisciplinary field. IC Postdoc Program is funding innovative research on the "Design and Control of Heterogeneous Microrobot Swarms," based on aerial microrobot platforms that use electrohydrodynamic (EHD) thrust to fly silently and with no moving parts. This research takes a unique approach to overcome thrust-to-weight challenges that trouble microrobotic development. True to the interdisciplinary nature of the field, initial success highlights the need for concurrent research and improvement in energy applications, specifically improved performance in DC-DC voltage conversion. These EHD- and other dielectric elastomer-, electrostatic-, or piezo-based microrobotic actuators all require high power density, miniaturized, and high voltage ratio converters that sit in a unique design space outside the typical purview of high-performance power electronics.

Example Approaches:

The inherent trade-offs among the operating frequency, the number of voltage multiplier stages, and the availability of suitable high-voltage diodes and high-frequency magnetic material are limiting the achievable specific power of state-of-the-art high voltage converters and slowing the progress of many exciting fields. While commercially available solutions may have specific powers suitable for larger and/or grounded robots, they are unsuitable for centimeter- and millimeter-scale robotics. There is potential for high impact work studying both new circuit topologies (e.g., high frequency switching resonant circuits) and new devices to populate them (e.g., high performance generic access network (GaN) power transistors and high-Q micro-electromechanical systems (MEMS) inductors).

A nanotech approach would require more basic research, but represents the appropriate applicable scale to microrobotics and various approaches. Energy harvesting via nanoscale machines (researchers have demonstrated success with a mesoscopic ratchet to collect dissipated heat energy) or development of thermal effusive materials, the creation of new super capacitating electrolytic surfaces or an entirely new class of bio-batteries illustrate the potential for nanoscale energy production.

Relevance to the Intelligence Community:

Microrobotics represents a promising future technological wave capable of meeting persistent monitoring and surveillance requirements against priority issues at low cost, but only if several vexing technical problems—including mobility, sensing, communication, and control—can be resolved. Progress in these areas would improve the IC's ability to monitor, warn, and provide senior leaders the decision space to address numerous dangerous and destabilizing issues.

Key Words: DC Converter, Microrobotics, Microbotics, Electrohydrodynamic, EHD, Energy Harvesting, Battery, Bio-batteries

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Qualifications

Postdoc Eligibility

- U.S. citizens only
- Ph.D. in a relevant field must be completed before beginning the appointment and within five years of the application deadline
- Proposal must be associated with an accredited U.S. university, college, or U.S. government laboratory
- Eligible candidates may only receive one award from the IC Postdoctoral Research Fellowship Program

Research Advisor Eligibility

- Must be an employee of an accredited U.S. university, college or U.S. government laboratory
- Are not required to be U.S. citizens

Eligibility Requirements

- **Citizenship:** U.S. Citizen Only
- **Degree:** Doctoral Degree.
- **Discipline(s):**
 - **Communications and Graphics Design** (2 )
 - **Computer, Information, and Data Sciences** (17 )
 - **Earth and Geosciences** (21 )
 - **Engineering** (27 )
 - **Environmental and Marine Sciences** (14 )
 - **Life Health and Medical Sciences** (46 )
 - **Mathematics and Statistics** (10 )
 - **Other Non-S&E** (2 )
 - **Other Physical Sciences** (12 )
 - **Other S&E-Related** (1 )
 - **Physics** (16 )
 - **Social and Behavioral Sciences** (27 )