Opportunity Title: Improving Energy Storage and Energy Harvesting in Internet of Things Wireless Sensor Nodes
Opportunity Reference Code: ICPD-2020-41

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 2/28/2020 6:00:00 PM Eastern Time Zone

Description

Research Topic Description, including Problem Statement:

The Internet of Things (IoT) is a growing market with predicted worldwide spending in this field to exceed $1.2T by 2022. This topic is focused on wireless sensor node (WSN) hardware which are designed to be cheap and easy to install without the need to integrate into existing infrastructure. Examples are smart electricity metering to ensure accurate monitoring of the National Grid load, smart home features e.g. internet connected thermostat lighting and security intruder detection and crop monitoring ensuring farmers can obtain real time data on soil quality and moisture content to improve yields.

However, use of WSNs are currently limited by a number of factors including; the energy density of small form factor power sources, sensor performance vs power consumption, device/maintenance overhead (e.g. battery change), efficiency of existing energy harvesting systems and more generally size, weight and costs.

The aim of this topic is to address shortcomings in the way WSNs are powered, with the broader goal of increasing the duration of the device. Proposals are welcomed that tackle this goal from a variety of different routes.

Proposals should look to build upon or surpass the current academic/industrial start of the art, some examples below:

- Small form factor energy storage – there are commercialized wearable medical trackers to measure body temperature when a fever is developing. They can be worn as an unobtrusive and conformable patch with Bluetooth connectivity to a smart phone, however they only have a 48 hour lifetime.
- Energy harvesters – There are commercialized thermoelectric generators (TEGs) and there has been a significant amount of academic publications.

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TEGs can provide ‘free’ power from a temperature differential, but typically this differential is difficult to maintain or the device is restricted to conditions where heating and cooling is readily available (i.e. a radiator pipe). This can often result in intermittent and unreliable power.

- Low power sensors – There has been development of ‘intelligent tags’ that off reduced power levels down to nanowatts to greatly increase the lifetime of a typical Lithium coin cell, but this comes with the limitation on the complexity of data that can be obtained.

Example Approaches:

The following examples highlight several strategies to improve the shortcoming in WSN power noted above. However, all proposals that address the aim will be considered.

- Using novel materials or assembly approaches to develop efficient energy harvesters that can function over a wider range of ambient conditions. This should aim to push forward the current technology which often provides insufficient or unreliable power.
- Develop an energy harvesting system that provides continuous and reliable power enabling WSNs to be battery free.
- Develop miniaturized primary or secondary battery technology in the order of mm3, but maintaining state of the art energy densities typically seen in larger packages (i.e. greater than 300 Wh/L).
- Increase the efficiency of power electronics used to covert harvested energy into useful power. For example the conversion of nanoamps of current at several kilovolts typically seen with piezoelectric harvesters to power WSNs currently results in significant power losses.

Relevance to the Intelligence Community:

With the rise of IoT there is the potential to autonomously, and in real time, efficiently monitor the location of deliveries, sense temperature and humidity or mitigate against damage, ultimately providing better supply chain providence. With increases in energy storage capabilities a network of WSNs can be incorporated and utilized much more efficiently.

Key Words: Internet of Things, IoT, Wireless Sensor Nodes, WSN, Battery, Batteries, Li-Ion, Lithium Polymer, Solid State, Energy Harvesting, Electrodynamic, Piezoelectric, Photovoltaic, Solar, Thermoelectric, Triboelectric, Power Electronics, Low Power

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

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- 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):**
  - **Chemistry and Materials Sciences** (12 👁)
  - **Communications and Graphics Design** (2 👁)
  - **Computer, Information, and Data Sciences** (16 👁)
  - **Earth and Geosciences** (21 👁)
  - **Engineering** (27 👁)
  - **Environmental and Marine Sciences** (14 👁)
  - **Life Health and Medical Sciences** (45 👁)
  - **Mathematics and Statistics** (10 👁)
  - **Other Non-Science & Engineering** (2 👁)
  - **Physics** (16 👁)
  - **Science & Engineering-related** (1 👁)
  - **Social and Behavioral Sciences** (27 👁)