NASA STTR 2016 Phase I Solicitation

T3.02 Self-Powered, Ultra-Miniature Devices

Lead Center: MSFC

Participating Center(s): GSFC, SSC

As the Human Exploration and Operations (HEOMD) Mission Directorate seeks technologies in support of NASA space operations related to human exploration in Space, development of technologies that address efficient energy usage and storage are considered to be of utmost importance. Development of a range of self-powered devices that maximize the safety and reliability of extended missions can only enhance human space flight capabilities in support of human and robotic exploration programs.

Suggested research appropriate for small colleges and universities, are development of Self-Powered Exploration Devices (SPED), and Miniature Ultra-power Storage Technologies (MUST). The SPED objective is to run a small self-powered mobile device around a small table-top, low-friction track using electrical energy generated by elements of the environment, with no stored power at the start. The energy source can be vibrational, acoustic, biological, chemical, thermal, solar, or any physical characteristic from the natural environment that can generate energy for storage or immediate use. The MUST objective is to run a small device continuously, from environmentally generated power, for an extended period of time, using a miniature capacitor, or battery, technology. A long running device is the objective.

These tasks are suitable for small academic institutions where probable long technology development time trajectories and low levels of focused technology development effort are ideally accommodating for students to mature to convergence with concurrently maturing respective technologies. The SPED and MUST technologies are designed to merge into a “Game Changing” Development (TRL 3-5) of Smart Dust Motes, partnering with a larger university already making advances in the field.

“Smart Dust Motes” are millimeter-scale self-contained micro-electromechanical devices (MEMS) that include sensors, computational ability, bi-directional wireless communications technology and a power supply. Size development as of about 2007, Hitachi, are tiny dust particle devices with dimensions of about 0.05 x 0.05 mm. This aggregate development, sensing/bi-directional wireless communication, hence “swarming”, is biomimetic. Potential future partnership possibilities are companies and institutions interested in low-bandwidth, low-power wireless mesh networks that transmit data using radio signals.

Finally, DARPA researchers pioneered the area of Dust Motes since the early ‘90s. Top research universities such as Berkeley, MIT, Stanford, etc., have also been active in this field, involving MEMS and the most recent advances in digital circuitry and wireless communication since inception of the idea. The challenges for Smart Dust are to create a package that includes all the elements needed to perform sensory measurements, while also being able to communicate back to a base station to process the data. The “Smart Dust Mote”, which could contain micro-fabricated sensors, optical receivers, passive and active optical transmitters, signal-processing and control circuitry, and power sources, in a MEMS device, is very highly advanced already, relative to someone just getting started. SPED/MUST research is ideal for smaller colleges and universities to gain experience in these areas. This positions them to participate in ultimate Dust Mote development ideal for a partnership arrangement.

Interested NASA directorates are, e.g., HEOMD, and STMD.