NASA SBIR 2016 Phase I Solicitation

H12.03 Novel Imaging Technologies for Space Medicine

Lead Center: GRC

Participating Center(s): JSC

NASA is seeking novel medical imaging techniques in two areas: software-based ultrasound and portable x-ray.

Software-Based Ultrasound

Ultrasound has been, and will continue to be for the foreseeable future, NASA's workhorse modality for internal imaging in space. Ultrasound's smaller footprint, lower power consumption and lower emissions across the electromagnetic spectrum make it particularly well-suited for space medicine. Ultrasound also provides additional medically useful capabilities outside the realm of imaging, such as quantitative ultrasound diagnostic techniques, and therapeutic techniques that utilize the energy in the ultrasound signal itself. NASA's commitment to ultrasound has led to the development of the Flexible Ultrasound System (FUS), which is a software-based, state of the art clinical scanner specially adapted to support the development of novel research in ultrasound. The FUS may be thought of as an "ultrasound development platform". It features software-based beam forming, scanning and receiving on up to 192 channels, dual-probe operation, high power support, and full access to the radio frequency (RF) data. Developers using the FUS may implement their algorithms and techniques in an Application Programming Interface (API) that supports both Matlab and C++.

The ground-based demonstration of the FUS will begin in April of 2016 and will potentially last for several years. NASA requires novel ultrasound-based diagnostic and therapeutic techniques for diagnosing and/or treating conditions on the Exploration Medical Condition List (EMCL), which can be found on NASA's Human Research Wiki at – (https://humanresearchwiki.jsc.nasa.gov/index.php?title=ExMC).

NASA is amenable to improving existing uses of ultrasound for both diagnostic and therapeutic purposes, but also for completely novel and innovative uses of ultrasound for diagnosis or treatment of any conditions on the EMCL. These novel techniques, which can include both hardware and software, should be developed with integration onto the FUS in mind, either by direct development on a system loaned to the developer by NASA or by porting the application from another system to the FUS at a later stage in the grant. Current examples of FUS integration include novel probe and algorithm development to quantify bone density and efforts to move/break up renal stones.

Portable X-Ray

Although ultrasound remains NASA's workhorse modality for internal imaging of body parts on spaceflight missions, there are gaps in ultrasound's ability to diagnose certain medical conditions that might arise during spaceflight, particularly to deep space destinations. Ultrasound is not as well suited to diagnosing dental conditions and certain musculoskeletal (MSK) injuries as traditional radiographic (x-ray) techniques. A set of limiting factors have precluded the use of x-ray devices on-orbit. These limitations include the relatively higher volumetric footprint, higher power requirements and higher electromagnetic (EM) emissions (particularly ionizing radiation, both in terms of dosage delivered to the crew and stray emissions) of x-ray devices and other imaging devices.

NASA needs new technology developments to overcome these limitations and ensure the diagnosis of dental and MSK conditions are more compatible with human spaceflight. NASA is amenable to improvements in existing x-ray devices and/or other novel and innovative imaging technologies. Example technology developments include, but are not limited to, those leading to more efficient x-ray sources, more sensitive detector technologies, improving image quality, reducing delivered EM dosage, and expanding the usefulness of handheld portable x-ray devices and other imaging devices to address dental and MSK conditions. A complete list of dental and MSK conditions can be found on the Exploration Medical Condition list (EMCL), which may be found on NASA's Human Research Wiki -

(https://humanresearchwiki.jsc.nasa.gov/index.php?title=ExMC).

Proposals should address one of the two aforementioned technology areas.

The expected deliverables for Phase I for the software-based ultrasound are:

- Conceptual prototype of a novel device/algorithm.
- Final report detailing the conceptual prototype and hardware/software development plans.

The expected deliverables for Phase II are:

- Completed FUS device/algorithm.
- Integrated testing on FUS platform.
- Final report on the development, testing, and validation of the tool.

The expected deliverables for Phase I for the portable x-ray are:

- Conceptual prototype of an imaging device.
- Final report detailing the conceptual prototype and hardware/software development plans.

The expected deliverables for Phase II are:

- Completed imaging device.
- Final report on the development and testing of the tool.