NASA SBIR 2011 Phase I Solicitation

X15 Space Human Factors and Food Systems

The emphasis on developing new, innovative technologies to enable future space exploration encompasses a need for new approaches in the areas of Space Human Factors and Food Systems. Operations in confined, isolated, and resource-constrained environments can lead to suboptimal human performance. Research and development activities in this topic address challenges that are fundamental to design, development, and operation of the next generation crewed space vehicles. These challenges include:

- Development of a software tool that automatically processes crew motion and interaction, either on orbit or on the ground, from video footage taken with a single conventional 2D camera to enable unobtrusive and non-invasive measurement of task performance and crew behavioral health.
- A need to develop a technology or system capable to prevent vitamin degradation of naturally-occurring and supplemented vitamins within a food substrate stored at ambient temperatures for five years. (http://humanresearchroadmap.nasa.gov/evidence/, http://www.nasa.gov/centers/johnson/slsd/about/divisions/hefd/index.html)

Subtopics

X15.01 A New Technique for Automated Analyses of Raw Operational Videos

Lead Center: JSC

Participating Center(s): ARC

Develop a software tool that automatically processes raw motion video footage (from a single conventional 2D camera) of a crew (spacecraft or ground) during a space mission.

Such a tool is needed to address vehicle/habitat design issues, as well as crew-to-crew interaction issues, on the ground. For example, unprocessed space mission operational videos down linked from a spacecraft that involve humans as the subjects of interest need to be analyzed on the ground for their motion and behavioral health information.

Requirements:

- The raw video data shall be video footages from a single conventional 2D camera and with no special lighting or fiduciary markers.
- The processed data shall contain the subjects' geometric information (position, movement, acceleration) relative to their operational environment and crewmates.
- A "tool chest" shall be available for visualization aids, velocity computations, etc. For visualization aids, the tool chest shall enable the user to specify areas or actions of interest. The software shall then locate, mark, count, etc. to indicate how many times the crew accessed a piece of hardware, traversed a path, reached above their heads, etc.

Desirable: 3D information extraction - ability to extract 3D information from the raw video to enable high-precision human motion analyses using the software's tool chest.

Phase I Deliverable: Algorithm

Phase II Deliverable: Functional software prototype

X15.02 Advanced Food Technologies

Lead Center: JSC

Participating Center(s): JSC

The purpose of the NASA Advanced Food Technology Project is to develop, evaluate and deliver food technologies for human centered spacecraft that will support crews on long duration missions beyond low-Earth orbit. Safe, nutritious, acceptable, and varied shelf-stable foods with a shelf life of 3 - 5 years will be required to support the crew during these exploration missions. Concurrently, the food system must efficiently balance appropriate vehicle resources such as mass, volume, water, air, waste, power, and crew time.

Refrigeration and freezing require dispensable resource utilization, so NASA provisions consist solely of shelf stable foods. Stability is achieved by thermal or irradiative processing to kill the microorganisms in the food or drying to prevent viability of the microorganisms. These methods do impact the micronutrients within the food substrate. Environmental factors (such as moisture ingress and oxidation) are also capable of compromising the nutrient content over the shelf life of the food. Since the food system is the designated source of nutrition to the crew, a significant loss in nutrient availability could significantly jeopardize the health and performance of the crew. Optimal nutritional content of the food for up to five years will ensure that the food can support crew performance and help protect their bodies from deficiencies that cause disease.

Vitamin content in NASA foods, such as Vitamin C, Vitamin A, thiamin, and folic acid, is degraded during processing and as the product ages in storage. The goal is to develop a system that protects the vitamins from this degradation at ambient temperatures over a five year duration. Possible technologies that could be investigated to protect food ingredients from biological and chemical degradation of components over time include nanoscale technologies (e.g., encapsulation), biosensors, novel food ingredients, and controlled-release systems. Technologies or systems that could aid in increasing the bioavailability of the nutrients should also be considered.

Phase I Requirements: Phase I should concentrate on the scientific, technical, and commercial merit and feasibility of the proposed innovation resulting in a feasibility report and concept, complete with analyses.

NASA Deliverable: A system which will result in higher nutrient content in shelf stable foods.