NASA SBIR 2007 Phase I Solicitation

X13.01  Space Human Factors Assessment Tools

Lead Center: JSC

Participating Center(s): ARC

The Human Research Program (HRP) and the Behavioral Health and Performance Research Program (BHP) are among NASA's major Space Human Factors research programs. In collaboration with these two programs, the SBIR program is looking for research proposals that address the following two research areas: (1) an Automated Human Factors Incident Reporting Tool (AHFIRT) and (2) a Cognitive Assessment Tool (CAT).

Automated Human Factors Incident Reporting Tool (AHFIRT)

The HRP provides human health and performance countermeasures, knowledge, technologies, and tools to enable safe, reliable, and productive long-duration human space exploration. Objectives of the HRP include developing capabilities and technologies to support and mitigate risks to crew health and performance, reducing human systems resource requirements (mass, volume, power, data, etc.), and ensuring effective human-system integration across exploration systems.

To support these objectives, the HRP determines that obtaining timely and context-specific Human Factors (HF) incidents data is a technology gap the program wants to address. Currently, space HF data come from crew debriefs. Such debriefs rely on retrospective recall, which could suffer delays of up to six months. Furthermore, opportunities to discuss HF issues in detail during these debriefs are limited. Consequently, the HRP sees the need to develop an Automated Human Factors Incident Reporting Tool (AHFIRT).

Objective: Development of an AHFIRT that assists the gathering and reporting HF incidents for long-duration space missions.
Requirements: In general, the AHFIRT will be used to help detect areas where HF can contribute to mission success, access the effects of operational and hardware changes, and complement existing HF data sources for operations including crew debriefs. Specifically, the AHFIRT shall meet the following requirements:

- The crew shall have easy access to the tool at any time to eliminate the need for the crew to recall information retrospectively.
- An easy-to-use data gathering protocol with the following functionalities:
  - Allow data to be entered either as text, audio, and/or video inputs
  - It is desirable for AHFIRT to detect system anomaly automatically and immediately record system status. At the minimum, however, the tools should provide an easily accessible event marker for the crew to mark the context and take a snapshot of the system and operator system status.
- Provide a user-friendly automated data search engine for extracting meaningful incident information from the raw data. Examples of desirable search schemes include natural language, spatial, temporal searches, etc.

Phase 1 Requirements: Technology Evaluation

The technical merit of the AHFIRT will be explored to evaluate feasibility. This process shall include:

- Evaluating/researching/developing automated data mining technologies
- Defining optimal data gathering protocol
- Determining optimal hardware/software design
- Developing hardware and software algorithms

Phase 2 Requirements: Prototype Development

The process shall include:
Developing a working AHFIRT prototype
Evaluate and test the functionality and usability of the prototype device

Cognitive Assessment Tool (CAT)

The NASA Behavioral Health and Performance Research Program (BHP) identifies and characterizes the behavioral health and performance risks associated with training, living and working in Space, and return to Earth. The BHP Research Element develops strategies, tools, and technologies to mitigate these risks. Currently, the BHP has the need for a Cognitive Assessment Tool (CAT).

Due to the high-intensity workload, disturbed sleep conditions, and other stressors of spaceflight, some astronauts have reported experiences of disturbed cognitive processes and fatigue.

Presently, a tool is utilized on the International Space Station (ISS) to detect neurocognitive deficits as a result of physical changes to the brain, which can occur from an injury to the head or exposure to a toxin. However, this assessment is designed as a programmed test that is not sensitive to crewmember fatigue. Consequently, there has been increased interest for a validated tool that can:

- Detect cognitive decrements as a result of fatigue or other stressors of spaceflight
- Support the Astronauts with an entertaining assessment activity(s)
- Support crew autonomy by providing objective feedback directly to the crewmember regarding their behavioral health

Objective: Design, develop, and fabricate a handheld, CAT that is in the form of a video game.

Requirements: The CAT game may include a suite of games as opposed to one single game. Ideally, the game would determine whether the player's deficit is a result of fatigue, stress, or neurocognitive impairment. Specifically, the CAT shall be as follows:

- In a hand-held video game format
- Portable hand-held unit
- Enjoyable and entertaining
• Flexible enough for increasing levels of difficulty

• Able to detect and identify cognitive decrements catalysts such as fatigue, stress, and/or neurocognitive deficits

• Able to provide immediate feedback to crewmembers, especially flight surgeons, with recommended countermeasure(s) based on his/her cognitive performance to support crew autonomy

Potential means for the CAT to assess performance may include measures of:

• Reaction times
• Accuracies
• Memory recall
• Complex decision making
• Physiological measures, such as heat rate via thumbs
• Speech acoustic analysis
• Facial monitoring
• Eye analysis

Note that the aforementioned methods are provided as examples of current research developments and are not intended as an all-inclusive or restrictive mandate for the development of the CAT.

Phase 1 Requirements: CAT Start-Up

The technical merit of the CAT will be explored to evaluate feasibility. This process will include:

• Defining predictors of cognitive decrements
• Determining which aspects of cognition should be assessed
• Determining optimal hardware design
• Hardware and software algorithms development

Phase 2 Requirements: CAT Research and Development
Content development of the CAT games should be determined based upon results of a qualitative study conducted with sample population (similar to Astronauts) to ensure corroboration and interest prior to the following stages:

- Develop software for gaming, data analysis, feedback, and recommended countermeasures
- Develop prototype hardware
- Develop manual and trouble shooting guide
- Evaluate and test the functionality of the prototype device.