



NASA SBIR 2017 Phase I Solicitation

H12.02 Advanced Model-based Adaptive Interfaces and Augmented Reality

Lead Center: JSC

Participating Center(s): ARC, JPL, KSC, MSFC

Technology Area: TA6 Human Health, Life Support and Habitation Systems

NASA is seeking innovative solutions for the design of adaptive interfaces for complex information systems that will be used on autonomous missions by crewmembers in various states of workload, stress, and fatigue.

Adaptive user interfaces, also called intelligent user interfaces, can decrease workload in cases of high attentional loads by presenting the information needed in simpler forms or in different formats. For example, to decrease attentional load, the interface may be modified from text to icons, or the interaction may change from written procedures to voice commands. There is evidence that workload can be reduced if some of the visual information is presented in a different modality or format in high attentional demand situations. Adaptive user interfaces can also provide displays that offer improved and optimized navigation tailored for the current state of the user. Interfaces can be augmented with visual and auditory elements that, again, adapt based on the needs of the user. Thus, the adaptability of the interface is increased in a different dimension. The augmented reality (AR) technology holds the promise to improve crew performance to execute complex procedures in a deep-space human spaceflight missions where communication back to the Earth-based mission control is limited and delayed.

In Phase I, a proof-of-concept prototype for an adaptive interface system with augmented reality should be developed and tested for a high workload (e.g., fault management or critical time constraints) scenario. The work should include a literature review on the effects of modality (visual, auditory, tactile, and combination of these) and format (e. g., text, icons, graphs) on workload. A model should be developed based on these principles, as well as an adaptive interface framework for a selected system used for spaceflight. Example scenarios and displays will be provided by NASA for this purpose. Model inputs can be simulated or emulated with hardware. The key technology areas are image registration, new software approaches to integrate augmented reality content from multimedia and multiple modalities, fusion of vision, human tracking, and integration of digital data with live sensor data and models.

In Phase II, the prototype adaptive interface system with augmented reality should be designed and validated for the selected high workload use case, as well as a procedure-based task. Display components should dynamically change as a function of the cognitive state and the level of expertise of the operator. The cognitive states (stress, fatigue, and workload) do not need to be measured or prototype; they can be simulated with various levels and treated as input parameters to the prototype. The usability of the prototype should be tested, including trigger events and timing of adaptation.

The team should include expertise on augmented reality, interface design, task analysis, and workload.

For all above technologies, research should be conducted to demonstrate technical feasibility during Phase I and show a path toward Phase II system/software demonstration and delivering a demonstration system/software

package including source code for NASA testing.

This technology will support NASA's Human Spaceflight Architecture Team List of Critical Technologies, including HAT 4.7.a-E Crew Autonomy Beyond LEO (systems and tools to provide the crew with independence from Earth-based ground support) and HAT 6.3.e-E Deep Space Mission Human Factors and Habitability (human factors technology in design).

For proposers who may be interested in applying these concepts to Aeronautics systems, please see Subtopic A3.01 - Advanced Air Traffic Management Systems Concepts.