Fiscal Year:	FY 2012	**Task Last Updated:**	FY 06/22/2012
PI Name:	Sandor, Aniko Ph.D.		
Project Title:	Displays and Controls Interfaces		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Space Human Factors Engineering		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **SHFH**:Space Human Factors & Habitability (archival in 2017)		
Human Research Program Risks:	(1) **HSIA**:Risk of Adverse Outcomes Due to Inadequate Human Systems Integration Architecture		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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City:	Houston	**State:**	TX
Zip Code:	77058	**Congressional District:**	22
Comments:			
Project Type:	Ground	**Solicitation / Funding Source:**	Directed Research
Start Date:	08/30/2010	**End Date:**	09/30/2013
No. of Post Docs:	0	**No. of PhD Degrees:**	0
No. of PhD Candidates:	0	**No. of Master' Degrees:**	0
No. of Master's Candidates:	0	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	0	**Monitoring Center:**	NASA JSC
Contact Monitor:	Sullivan, Thomas	**Contact Phone:**	
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Flight Program:			
Flight Assignment:	NOTE: End date changed to 9/30/2013 per HRP Master Task List information dtd 11/11/2011 (Ed., 1/5/2012)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Archer, Ronald (Lockheed-Martin/ NASA Johnson Space Center) Thompson, Shelby G. (Lockheed Martin)		
Grant/Contract No.:	Directed Research		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Future exploration missions will require much greater crew autonomy, particularly for suited operations. Crews will be extremely dependent on the information available within the spacesuit for monitoring their health and suit resources, and for performing tasks. Suit data such as battery power, oxygen remaining, crew biomedical data, procedure and task information, and navigational data are all needed by EVA crewmembers to successfully complete their mission. If informational displays are poorly designed, or not easily accessible, crews will not have access to critical data, putting their mission and personal safety at risk. Suits pose special challenges in terms of information display and interaction, given limited display real estate, and gloves and helmets compromise vision, hearing, and touch. The methods by which information is delivered need to support, not hinder, task completion. Current EVA crewmembers depend heavily on communication with the ground for completion of their tasks. Future missions to more distant destinations will require a much different approach to ensure crew independence. This line of research will focus on: 1) special techniques for formatting data delivered in a spacesuit, and 2) mechanisms for delivering and interacting with that data, given suit constraints. Researchers will first identify the different classes of information needed by the suited crewmember, then determine the modality and format of the data required for each class, and finally investigate the best technology solution to provide the data. Researchers will work with EVA Physiology, Systems and Performance (EPSP) researchers and developers using the metabolic data display issue as a case study. Various information designs and technology solutions will be empirically compared and requirements developed. Methods to be used consist of the following: Task analysis, to identify and understand the suited tasks to be performed, including interviews with EVA astronauts to understand suited information needs and issues from the astronauts perspective; literature reviews on different information display techniques for different classes of data (e.g., procedures, alarms, metabolic data) and available technologies (e.g., Head Mounted Displays (HMDs), cuff checklists, voice); and usability testing and experimental studies to assess human performance with the proposed designs using metrics such as error rates, task completion times, verbal protocol comments, and questionnaire responses, ratings, and rankings. Standard parametric and non-parametric statistical methods will be used for data analysis. Multiple methods, metrics, and information developed as part of the Information Presentation (2008-2010) DRP will be leveraged in this project, including information on labels, alarms, cursor control devices, HMDs, and health and status displays. Products developed as part of the Usability (2008-2009) Directed Research Project will be validated as part of this new DRP, including methods and metrics for error rates, legibility, and consistency.
Rationale for HRP Directed Research:	This research is directed because it contains highly constrained research, which requires focused and constrained data gathering and analysis that is more appropriately obtained through a non-competitive proposal.
Research Impact/Earth Benefits:	
Task Progress:	Data for suit health and status are displayed on specific EVA informational displays. Suits pose special challenges in terms of information display and interaction, given limited display real estate. Furthermore, EVA gloves and helmets compromise vision, hearing, and touch. The methods by which information is delivered need to support task completion. If informational displays are poorly designed, or not easily accessible, crews will not have access to critical data, putting their mission and personal safety at risk. Current EVA crewmembers also depend heavily on communication with the ground for completion of their tasks that adds to the complexity of interfaces. Future missions to more distant destinations will require an approach that makes information presentation to EVA crews more efficient to ensure crew independence. In order to prepare for designing an EVA display for suit health and status information, the Displays and Controls Interfaces team conducted a literature review on data visualization methods. The purpose of this report was to review data visualization options for presenting the data needed on an EVA mission. For example, the current status of the oxygen level may be presented with an icon and the rate of the consumption with a trend graph. For easy interpretation, the type of icon and graphs needs to be selected carefully. Furthermore, the details shown on these visualizations have to follow human factors guidelines to make sure that the data visualization supports crew tasks providing high accuracy and short interpretation time. The report summarized visualization methods such as tables, graphs, and multidimensional icons. One of the display types that may be used for EVA information presentation is head-mounted displays. Due to the specific features of these displays, it is important to look at existing specific standards for display design due to their size and short viewing distance used with these displays. A literature review was conducted on existing standards and studies for displaying information on head-mounted displays. Based on the information the team collected from crew and flight controllers on EVA consumables, as well as from the literature review on data visualization methods, work could start on designing an EVA display prototype and icons that could present summarized information on consumables. A study was conducted to evaluate several approaches to tables, icons, representation with sounds. A second study was conducted using only data presentation with sounds, a method called sonification. Each consumable was represented by a tone. The tones were the same for each consumable, except for the one that was predicted to run out first. Sonification can be used for simple data presentations and it can be useful in situations when the eyes are busy. A third study looked at visualizing the health and status of multi-crew teams: multidimensional icons were used to show EVA consumable data for each crew member. This type of visualization is very useful for visually compare multidimensional data sets. The user can quickly assess differences among multidimensional icons, as well as getting an overall picture of the situation. Finally, the team designed a prototype interface for an existing metabolic rate advisor system, the Legaci system, developed in 2008. This system uses EVA consumable data to calculate metabolic rates. In addition, a voice commanding system is integrated that allows users to access the data hands-free during an EVA. The new integrated system prototype was evaluated with crew representatives, flight controllers, and subject matter experts to get feedback on the design. The interface prototype will be further developed in FY13-FY14.
Bibliography Type:	Description: (Last Updated: 03/03/2016)