Fiscal Year:	FY 2020	**Task Last Updated:**	FY 03/13/2020
PI Name:	Schreckenghost, Debra M.E.E.		
Project Title:	HCAAM VNSCOR: Enhancing Situation Awareness of Automated Procedures Using Adaptive Multimodal Augmented Reality Displays		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
Joint Agency Name:		**TechPort:**	Yes
Human Research Program Elements:	(1) **HFBP**:Human Factors & Behavioral Performance (IRP Rev H)		
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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Zip Code:	77058	**Congressional District:**	22
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	2017-2018 HERO 80JSC017N0001-BPBA Topics in Biological, Physiological, and Behavioral Adaptations to Spaceflight. Appendix C
Start Date:	05/15/2019	**End Date:**	05/14/2023
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
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Flight Program:			
Flight Assignment:	NOTE: End date changed to 5/14/2023 per S. Huppman/HRP and NSSC information (Ed., 3/3/2020)		
Key Personnel Changes/Previous PI:	March 2020 report: There are no key personnel changes.		
COI Name (Institution):	Holden, Kritina Ph.D. (NASA Johnson Space Center) Dory, Jonathan B.S. (NASA Johnson Space Center)		
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Performance Goal No.:			
Performance Goal Text:			

Task Description:	This task is part of the Human Capabilities Assessments for Autonomous Missions (HCAAM) Virtual NASA Specialized Center of Research (VNSCOR). Future deep space missions will present new challenges for crew, and increased risks to human performance due to the stress, fatigue, radiation exposure, and isolation that characterizes these missions. In addition, crew will no longer be able to depend on timely support from Mission Control due to distance from the Earth, but will have to work autonomously, while maintaining high performance. Mission Controllers may not be available to answer questions, check system status, assist with procedures, monitor for errors, or troubleshoot problems. Greater crew autonomy will increase dependence on automated systems, and design of these automated systems must be driven by sound human-system integration standards and guidelines in order to ensure mission success. Historically, crew have had very limited dependence on automated systems, thus crew will be faced with a new way of working that may put situation awareness (SA) at risk. We must develop methods for promoting good situation awareness in the automated systems that will most certainly be part of future deep space vehicles and habitats. Procedure automation is a promising technology for reducing crew workload. We define procedure automation as technology that automates the selection or execution of procedural tasks. Structuring the work of automation according to human procedures should improve the transparency of automation actions. This approach provides a means for establishing common ground about ongoing tasks to improve operator understanding of automation behavior. New technologies such as adaptive, multimodal, augmented reality displays can offer the benefits of information presentation tailored to meet the needs of each crewmember, taking into consideration the current state of that crewmember (e.g., sleep-deprived, high workload), as well as the current state of his/her environment and ongoing activities (e.g., emergency situation, time-critical operations). We propose to combine technology for procedure automation with technology for augmented reality multi-modal (ARMM) user interfaces using Microsoft Hololens head-mounted display to provide a virtual task assistant to assist crew in performing procedural work. This virtual task assistant will be capable of identifying which procedures should be performed, performing actions in crew procedures, and summarizing actions taken by the human-automation team to assist crew in preparing for tasks and taking over tasks from other team members. Four studies are planned to evaluate the effects of a virtual task assistant combining procedure automation with augmented reality multi-modal (AARM) user interfaces on human task performance. These studies will achieve the following aims: Aim 1. Determine best methods to improve situation awareness and improve crew autonomy when using a virtual task assistant to prepare for and perform manual maintenance. Aim 2. Determine best methods to improve situation awareness and reduce workload when a virtual task assistant is used to handover maintenance tasks between users. Aim 3. Determine best methods to improve situation awareness and reduce workload when using a virtual task assistant to help manage concurrent manual and automated tasks. The proposed work addresses a number of gaps in the Human Research Program Human Factors and Behavioral Performance risks. This project will provide guidelines for designing effective human-automation systems (Human and Automated/Robotic Interactions (HARI)-02) and evaluate human-automation performance for exemplar procedure automation systems (HARI-03). This project also will provide guidance for the application of multi-modal and adaptive displays and control to Human-Computer Interaction (HCI) design for long duration operations (HCI-04).
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Technologies for virtual task assistance are increasingly available in everyday life. One of the most common is voice enabled assistance, like Siri and Alexa, that aid some activities of daily living. And augmented and virtual reality technologies are becoming mainstream, with the introduction of new devices such as Microsoft HoloLens 2, and improved standards such as the WebXR standards (https://) for accessing virtual and augmented reality devices. The VITA project is leveraging augmented reality platforms and new WebXR standards to develop a virtual task assistant that can be used to assist users with procedural task work on the job. Our technical approach is innovative in that new procedural tasks can be supported without custom software development. Our experimental research is distinguished by investigating effective task assistance for maintenance or assembly tasks where hands-free operation of task assistance is beneficial. For the first year we are investigating best techniques for using augmented reality task assistance when assembling small devices that are held in the hands during assembly. This technology and associated research findings have potential benefit to NASA for the assembly, maintenance, and repair of aircraft, spacecraft, habitats, and robotics. This technology and associated research findings also have broader potential benefit for any organization performing assembly and maintenance procedural work. This includes assembly and maintenance of drilling equipment for the oil and gas industry, equipment used in chemical processing plants, and maintenance and repair of commercial aircraft.
	The Virtual Intelligent Task Assistant (VITA) project investigates the effects of a virtual task assistant on human performance of procedural work. The virtual task assistant combines procedure automation with augmented reality multi-modal user interfaces. Procedure assistance will be provided in a Microsoft HoloLens headset that can present information in augmented reality overlays of the visual field. The virtual task assistant will assist users in becoming familiar with planned procedures, in performing procedure actions, and in maintaining awareness of procedure actions taken by other crewmembers or automation. Human performance will be compared with and without the virtual task assistant with the goal of informing best methods for delivering and using such virtual task assistants. The aims of this research are listed below. Aim 1. Determine best methods to improve situation awareness and improve crew autonomy when using a virtual task assistant to prepare for and perform manual maintenance. Aim 2. Determine best methods to improve situation awareness and reduce workload when a virtual task assistant is used to handover maintenance tasks between users

Task Progress:	Aim 3. Determine best methods to improve situation awareness and reduce workload when using a virtual task assistant to help manage concurrent manual and automated tasks. Research during the first year of this project addresses Aim 1. To achieve Aim 1, we will conduct a study in the Human Exploration Research Analog (HERA). This study will investigate the usability and effectiveness of the virtual task assistant to improve crew autonomy in the HERA Campaign 6. Effectiveness in increasing crew autonomy will be indicated by the number and type of interactions with Mission Control Center (MCC) or other crewmembers made during this experiment. Usability will be measured using the System Usability Scale (SUS). The VITA project is conducting two studies to determine the best methods to improve situation awareness and improve crew autonomy when using a virtual task assistant to prepare for and perform manual maintenance and assembly (Project Aim 1). These studies attempt to answer the question posed in the proposal: “Can the virtual task assistant stand-in for MCC and help crew prepare for and perform manual tasks that are not done frequently, such as equipment maintenance and assembly?” During the definition phase of the VITA project, the research team focused on the initialization of the VITA project including detailed coordination with the other teams in the Human Capabilities Assessments for Autonomous Missions (HCAAM) Virtual NASA Specialized Center of Research (VNSCOR), and with NASA’s Flight Analogs Program to ensure seamless integration for the HERA Campaign 6. NASA Johnson Space Center Institutional Review Board (JSC IRB) was submitted and approved for the VITA project. An integrated plan for using the HERA facility was developed with support from the HERA Experiment Support Scientist (ESS). The Science Requirements Document (SRD) for the VITA HERA experiment was created, reviewed, and signed. The VITA study timeline was developed with the HERA ESS. The studies for VITA project aim 1 were defined and implementation of these studies was begun. The first study is a pilot laboratory study to determine techniques for use in the second study, to be conducted in HERA Campaign 6. Both studies will investigate situation awareness and workload when using VITA to help the user prepare for and perform a manual assembly task. Specifically, VITA will assist the human in assembling and disassembling a small rover. The rover can be configured with a gripper or with multiple alternative means of locomotion. The virtual task assistant will use augmented reality and multi-modal techniques to prompt and inform the user when performing assembly tasks on the rover. Participants will complete the rover assembly procedure task under three procedure completion conditions: 1) individual participants with electronic procedures on a tablet, 2) individual participants with VITA task assistant, and 3) a team of two participants with electronic procedures on a tablet. Participants will cycle across a unique set of rover procedures, following random assignment. SA and Workload measures while using the VITA task assistant will be compared with baseline performance using assembly procedures in typical electronic procedure displays for NASA (such as Orion or International Space Station (ISS) displays)) available on a portable tablet. The technology for the VITA task assistant to be used in this experiment also was integrated during the definition phase. The HoloLens 1 was integrated with the PRIDE electronic procedure software extended for augmented reality (PRIDEAVR). This integrated technology was validated to produce contextual virtual-assistant directions to crewmember. The VITA task assistant user interface was designed and implemented. This user interface is implemented as a web user interface, which permits displaying it in either the HoloLens or on a tablet. During the definition phase, equipment also was procured for both the pilot study and the HERA Campaign 6 study. At the time this report was submitted, the first VITA study was in progress. We do not yet have experimental findings to report from this study. The second study to be conducted in HERA Campaign 6 has been designed, technology has been integrated, and preparation for hardware and software delivery to HERA is in progress. The last quarter of Year 1 will focus on preparation for the study to be conducted in HERA Campaign 6. This includes continuing the pilot study started in the definition phase to evaluate experimental techniques for the HERA C6 study. The study to be conducted in HERA Campaign 6 should start in Year 2 (expected start in August 2020).
Bibliography Type:	Description: (Last Updated: 04/10/2024)