Fiscal Year:	FY 2021	**Task Last Updated:**	FY 01/06/2021
PI Name:	Fanchiang, Christine Ph.D.		
Project Title:	HCAAM VNSCOR: Using a Human Capabilities Framework to Quantify Crew Task Performance in Human-Robotic Systems		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
Joint Agency Name:		**TechPort:**	No
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		
PI Email:	christine@tsrco.com	**Fax:**	FY
PI Organization Type:	INDUSTRY	**Phone:**	650-302-2692
Organization Name:	Space Research Company LLC		
PI Address 1:	6715 S Adams Way		
PI Address 2:			
PI Web Page:			
City:	Centennial	**State:**	CO
Zip Code:	80122-1801	**Congressional District:**	6
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:	04/15/2019	**End Date:**	04/14/2023
No. of Post Docs:		**No. of PhD Degrees:**	
No. of PhD Candidates:	1	**No. of Master' Degrees:**	
No. of Master's Candidates:		**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:		**Monitoring Center:**	NASA JSC
Contact Monitor:	Whitmire, Alexandra	**Contact Phone:**	
Contact Email:	alexandra.m.whitmire@nasa.gov		
Flight Program:			
Flight Assignment:	NOTE: Start date changed to 4/15/2019 per NSSC information (Ed., 5/18/21) NOTE: End date changed to 4/14/2023 per NSSC information (Ed., 1/22/2020)		
Key Personnel Changes/Previous PI:	March 2020 report: Change to graduate student for upcoming semester.		
COI Name (Institution):	Klaus, David Ph.D. (University of Colorado, Boulder) Shelhamer, Mark Sc.D. (Johns Hopkins University)		
Grant/Contract No.:	80NSSC19K0655		
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). Effective space exploration will require proper task coordination between humans and robotic systems. These systems can be characterized in a variety of ways, from level of autonomy to the number of functions provided. At the most basic level a robotic system can be considered a hand tool while something more complex could be a humanoid companion. To ensure the robotic system is effective, the crew must trust that the system performs its intended function(s), or retain enough Situation Awareness (SA) and capability to find another way to execute the required task. Currently, there are no comprehensive standards for measuring, monitoring, and evaluating task performance with regard to crewmember capabilities, the design of the task, and the dynamic spacecraft environment. This work seeks to address this missing performance infrastructure by providing a conceptual framework for measuring task design quality and developing a path for validation using a task performance metric through experimentation both in university labs and using NASA's analog missions.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Leveraging wearable technologies for monitoring human health and performance is beneficial for a range of people here on Earth whether it is for elite athletes to rehabilitation patients in the hospital. Currently, there are limitations to the use and integration of data from various wearable sensors. The work done for this project will help to provide some guidance regarding wearable data integration and effectiveness of the data for predicting performance degradation. The ability to predict changes in performance can be useful for a number of scenarios here on Earth.
Task Progress:	The objective of this investigation is to provide a method for validating a previously defined Task Design Framework, which describes the relationship between human capabilities and performance. The approach is to have human subjects perform representative spaceflight-like task scenarios while being monitored by a suite of non-invasive biometric measures. The data collected will be analyzed to determine whether these non-invasive biometric measures can be used as proxy indicators to performance changes. The work performed this year was adjusted to fit the extenuating circumstances of a global pandemic. Our team's assumption is that the pandemic will still be ongoing through the following year or two and therefore we made accommodations to our human subject testing to ensure safe protocols for both the subject and the test operator(s). Additionally, all of the work described in this report was done remotely with no direct contact between people. During the first part of this grant year, the Human Exploration Research Analog (HERA) campaign test sets were finalized and submitted for inclusion in the HERA #6 campaign. These test sets utilized both arithmetic questions and a modified trail mapping test to stress HERA participants' cognition for quantification of their cognitive states. Cognitive load measures will be monitored with a portable fNIRS system, which was also packaged and shipped to Johnson Space Center (JSC). To track the impacts of environmental factors, a CO2 meter, sound meter, light meter, and temperature/humidity sensors were also delivered to JSC. A simple Food Log spreadsheet was developed and sent to HERA for the subjects to log their daily water and food intake. In response to the ongoing coronavirus national crisis, steps were taken to ensure that testing could proceed without introducing any added risk of COVID-19 contraction among test participants or the test operator(s). In order to implement this mitigation strategy several updates to the original proposal research approach were required. The primary change was moving the testing to an At-Home protocol consisting of step-by-step instructions for the test participant and the development of a mobile/portable testing system that includes a stationary bike set-up with a tablet with pre-loaded instructional software with specific testing instructions. Prior to deploying our At-Home Test Protocol, our team tested the protocol extensively to ensure we could extract the appropriate data and that the instructions were easy to follow for a subject with limited guidance from our team. Through this testing phase, our team characterized the suite of biometric sensor behavior across four task types represented as low cognitive, no physical; low cognitive, high physical; high cognitive, no physical; and high cognitive, high physical tasks. This testing helped guide modifications to the protocol including changing the duration of testing phases, modifying the cognitive load task to increase difficulty and streamlining the software instructions. An engineering test subject was recruited to specifically test the full deployment of our At-Home Test Protocol. The test subject did not have prior familiarization of the hardware or instructions and provided feedback throughout the process. The data gathered from the engineering test subject has provided an wealth of data to analyze and is being used to develop our preliminary post-processing algorithms for interpreting the data and integrating it into the Crew Performance Framework.
Bibliography Type:	Description: (Last Updated: 02/26/2025)
Papers from Meeting Proceedings	Fanchiang C, Seyedmadani K, Zero M, Shelhamer M, Klaus D. "Characterizing a biometric sensor suite as an approach for astronaut performance model validation." 50th International Conference on Environmental Systems, Virtual, July 12-15, 2021. 50th International Conference on Environmental Systems, Virtual, July 12-15, 2021. ICES paper ICES-2021-405. https://hdl.handle.net/2346/87297 , Jul-2021