Fiscal Year:	FY 2020	**Task Last Updated:**	FY 01/06/2020
PI Name:	Selva, Daniel Ph.D.		
Project Title:	HCAAM VNSCOR: Virtual Assistant for Spacecraft Anomaly Treatment During Long Duration Exploration Missions		
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:	77843-0001	**Congressional District:**	17
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:	03/06/2019	**End Date:**	03/05/2023
No. of Post Docs:	0	**No. of PhD Degrees:**	0
No. of PhD Candidates:	2	**No. of Master' Degrees:**	0
No. of Master's Candidates:	0	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	2	**Monitoring Center:**	NASA JSC
Contact Monitor:	Williams, Thomas	**Contact Phone:**	281-483-8773
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Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Diaz Artiles, Ana Ph.D. (Texas A&M Engineering Experiment Station) Dunbar, Bonnie Ph.D. (Texas A&M Engineering Experiment Station) Wong, Raymond Ka Wai Ph.D. (Texas A & M, College Station)		
Grant/Contract No.:	80NSSC19K0656		
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). The research objective of this proposal is to investigate the impact of using Virtual Assistants (VA) to support crew members in the context of anomaly treatment during Long Duration Exploration Missions (LDEM), when ground support will be limited. A VA will be developed building upon the software architecture from existing VAs developed by the Principal Investigator (PI) for similar purposes. The VA will provide support for various aspects of anomaly treatment, including detecting and diagnosing the anomaly, as well as recommending a course of action. It will also have the ability to take initiative in the dialog with the user (mixed-initiative mode), and the ability to provide explanations for its actions. The impact of the VA on performance, cognitive workload, situational awareness, and trust, will be assessed through a set of three experiments with human subjects in a laboratory environment. The first experiment will establish the baseline impact (master-slave, no explanations), and subsequent experiments will study the effect of switching to the mixed-initiative mode and adding explanations. The system will also be deployed and tested in the Human Exploration Research Analog (HERA) analog environment.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	This project will provide standards and guidelines that will help NASA design similar virtual assistants to support astronauts during future long duration exploration missions. Such standards and guidelines will concern both the functionality and the user interface of the virtual assistant.
Task Progress:	This project is one of seven projects in the Virtual NASA Specialized Center of Research (VNSCOR) for Human Capabilities Assessments for Autonomous Missions (HCAAM). The goal of our project is to develop a virtual assistant to help astronauts with anomaly resolution in long duration exploration missions. In the first year of this project, we have completed a project definition phase in which we have more crisply defined the scientific objectives and the technical approach to design the virtual assistant. We started by selecting the Environmental Control and Life Support Subsystem (ECLSS) as the technical scope for the virtual assistant. We then proceeded to elicit high level requirements and use cases and perform the early design of the virtual assistant, which we are getting ready to test in our laboratory at Texas A&M University in the next month. Specifically, in this first year, we have accomplished the following: 1) We have defined the high-level requirements and overall software architecture of the virtual assistant. 2) We have defined how the virtual assistant will interface with the Human Exploration Research Analog (HERA) infrastructure. 3) We have developed the first very basic prototype of the virtual assistant which includes: a) a simple anomaly database; b) a simple database containing knowledge about how the ECLSS system works in HERA and how to perform some maintenance and repair operations; c) an interface with the HERA simulated telemetry feed, which provides a data stream with all the measurements of the ECLSS subsystem; d) a web-based graphical user interface containing a main plot window displaying the telemetry feed and a chat box to chat with the virtual assistant; e) the natural language processing layer that the assistant uses to process the natural language requests; f) the machine learning layer that is used to understand the intent of the question and send it to the relevant part of the software, i.e., the one that knows how to answer it; f) the first version of the back end of the software, which is precisely the part of the software that performs the calculations needed to answer the questions and requests from the user. While this first prototype is not sophisticated in terms of the breadth and depth of questions it can answer, it still has most of the main functionality expected of the assistant. Specifically: 1) it warns the user when a measurement from the telemetry feed exceed some user-defined thresholds; 2) it also performs statistical analysis on the data stream and warns the user if the measurement is considered an outlier, even if it is within the user-defined thresholds; 3) once an anomaly is detected (e.g., increase in CO2 concentration), it provides the users with some possible root causes for it, in order of likelihood (e.g., a malfunctioning filter or a leak); 4) once the anomaly has been diagnosed (faulty filter), it provides the user with relevant procedures to reconfigure the system (how to change the CO2 filter). In parallel of the software development, we have also started planning and designing the experiments. We are currently getting ready to start a pilot experiment at Texas A&M in order to refine both the software implementation and the experimental design. The results of this pilot experiment will help us get ready for the HERA campaign, which is currently scheduled for August 2020. Since the beginning of the project, we have been working with the HERA team to prepare for the experiment. We obtained approval from the Institutional Review Boards of both NASA and Texas A&M. We provided our input to the experiment support specialist to create our science requirements document and are currently working on the investigator working group, getting ready for a software delivery to NASA by March. We have also been in constant communication with the rest of the VNSCOR to ensure compatibility of our experiments and try to make the most of any potential synergies. Finally, in terms of publications, we are about to present a peer-reviewed full paper at the 2020 American Institute of Aeronautics and Astronautics (AIAA) Scitech conference. We also have two poster presentations at the 2020 Human Research Program workshop later this month. In the next few months, we will keep adding functionality to the assistant so that it can answer more questions better and provide more useful information to the user. We anticipate that some rework of the telemetry feed interface will be necessary to adapt to some changes on the HERA side. We will also refine the user interface with the results from the pilot. We are getting ready to conduct a preliminary design review in March before delivery to HERA. Between March and August 2020 we will work on integrating our software with HERA. We will conduct a Critical Design Review in June 2020 and an Operational Readiness Review in August 2020, right before ingress. Between August 2020 and September 2021 we will support the 4 missions of the C6 HERA campaign.
Bibliography Type:	Description: (Last Updated: 02/23/2024)

Papers from Meeting Proceedings	Dutta P, Balcells Quintana O, Viros A, Whittle RS, Poonampreet KJ, Beebe N, Dunbar BJ, Wong RK, Diaz-Artiles A, Diaz-Artiles SD, Ana Selva D. "Virtual Assistant for Anomaly Treatment in Long Duration Exploration Missions." Presented at the 2020 AIAA SciTech Forum, Orlando, FL, January 6-10, 2020. Paper AIAA 2020-2255. 2020 AIAA SciTech Forum, Orlando, FL, January 6-10, 2020. https://doi.org/10.2514/6.2020-2255 , Jan-2020