Fiscal Year:	FY 2023	**Task Last Updated:**	FY 10/04/2022
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Project Title:	Development of a Computer Vision Based Toolbox for Feature Extraction, Analysis, Modeling, and Prediction of Microgravity Data Sets		
Division Name:	Physical Sciences		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:	FLUID PHYSICS--Complex fluids MATERIALS SCIENCE--Materials science OTHER--Other		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	None		
Human Research Program Risks:	None		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Comments:			
Project Type:	GROUND,Physical Sciences Informatics (PSI)	**Solicitation / Funding Source:**	2021 Physical Sciences NNH21ZDA014N-PSI: Use of the NASA Physical Sciences Informatics System – Appendix G
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No. of PhD Candidates:		**No. of Master' Degrees:**	
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No. of Bachelor's Candidates:		**Monitoring Center:**	NASA MSFC
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Flight Program:			
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Task Description:	Over two decades of significant effort and resources have been devoted to investigating a broad spectrum of hypotheses in microgravity across the portfolio of physical and life sciences on the International Space Station (ISS). This work has resulted in an impressive amount of data being collected, in particular images and videos. However, much of this image data, to date, remains underutilized because the emphasis continues to be on individual investigations. In this proposal, G-SPACE takes a cross-cutting look at the Physical Science Informatics (PSI) datasets to build a simple computer vision, data analytics, and machine learning tool (ATOM™ toolbox) that would be an enabler to all the PSI users (in particular new PIs) to better interact with the data, standardize data output, and perform insightful analysis on the selected datasets to increase the science readiness of their investigations. For the past two years, the G-SPACE team has been actively ingesting microgravity data available in the NASA PSI database for the purpose of applying a suite of proprietary algorithms and models from its ATOM™ software platform to extract the delta-to-gravity (™) and utilize it to design and optimize products and manufacturing processes amenable for in-space manufacturing. The platform aims to bridge the gap between microgravity R&D sciences and in-space manufacturing and our team's hope was that the PSI database would have clean data sets corresponding to ground and flight experiments for ATOM™ to extract the delta-to-gravity™ and focus on microgravity product design and optimization. Unfortunately the data in the PSI database is simply not ready for this approach. The video data residing in the PSI database has rarely been analyzed to track key features for research, and even if so, it has not been done in an automated manner. The sheer number of images, and the total size of the data set, require an enormous amount of hand-sorting and checking of images and is only available in an unstructured format. This makes it harder for users to find and understand the value that lies in it since to access that information it requires crossing a very high barrier, especially for new Principal Investigators (PIs) who do not usually have previous familiarity. The current proposal seeks to develop the ATOM™ toolbox, a collection of generic computer vision, data analysis, and machine learning functionalities to help new PIs, as well as existing users, to expand the meaning and interpretation of existing data sets, and to extract heretofore undiscovered knowledge from the PSI database. It will also: (a) enable enhancement of existing data, (b) open up the ability for new researchers to leverage on existing experiments, and (c) help bring the investigations to a faster conclusion. To develop the ATOM™ toolbox functionalities, the G-SPACE team will look at images and videos only for eight (8) Material Science and two (2) Complex Fluid investigations in the PSI database. Besides being a powerful tool to extract meaningful information from existing experiments, the ATOM™ toolbox could ultimately provide: (1) the means to guide ISS experiments to make better use of time in microgravity, (2) a mechanism to predict results of future experiments in space for better prioritization and structure in the decision process, and (3) an open door for applications that ultimately create the path towards materials space manufacturing and beyond. The end products of the two years' effort under this proposal that will be delivered to NASA, to be included in the PSI database, will consist of: (1) a database of structured image/video datasets and a corresponding demo for each of the 10 investigations, (2) the ATOM™ toolbox with a basic application programming interface (API) to allow integration with the PSI database and the G-SPACE ATOM™ platform.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	The G-SPACE platform: 1. Enables microgravity users to access modern data science and machine learning algorithms specifically tuned to analyze microgravity data, quantify microgravity impact, and establish correlations with environmental variables; 2. Democratize and disseminate microgravity know-how and open up the ability for new researchers to leverage on existing experiments and propose new investigations; 3. Reduce the barrier of entry of new users in the field of microgravity research; 4. Enhance the value of existing data and help increase the science readiness of microgravity investigations; 5. Spark applications towards in-space manufacturing.
Task Progress:	New project for FY2023.
Bibliography Type:	Description: (Last Updated: 10/11/2023)