Fiscal Year:	FY 2024	**Task Last Updated:**	FY 10/01/2023
PI Name:	Cozmuta, Ioana Ph.D.		
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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Zip Code:	94087-1559	**Congressional District:**	17
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
Start Date:	10/01/2022	**End Date:**	09/30/2024
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 MSFC
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Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:	No change in PI. Key Personnel Changes: Dr. Christianna Taylor is responsible for the software development aspects of the platform (replacing Dr. Tibi Stef-Praun). Dr. Brian Motil is a former microgravity PI with over 30 years working at NASA and he will be responsible for the datasets' structuring and processing. Both Dr. Taylor and Dr. Motil joined the team in November 2022.		
COI Name (Institution):			
Grant/Contract No.:	80NSSC22K1885		
Performance Goal No.:			
Performance Goal Text:			

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:	This document constitutes the Year 1 report of work conducted within the scope of the NASA award "Development of a Computer Vision Based Toolbox for Feature Extraction, Analysis, Modeling, and Prediction of Microgravity Data Sets" (grant 80NSSC22K1885). The work focuses on two key objectives: 1) Create a database of 10 structured image/video datasets from Physical Sciences Informatics (PSI) with a standard file format, clear labeling, and one-to-one traceability to terrestrial data when possible. A brief corresponding ATOM™ demo for each of the 10 investigations will also be developed. 2) Develop the ATOM™ toolbox with a basic application programming interface (API) to allow integration with the PSI database and the G-SPACE ATOM™ platform. At the end of Year 1, work on six of the structured datasets has been finalized, while work on the remaining four is ongoing. Significant progress has been made in the development of key features for the G-SPACE ATOM™ Toolbox, which includes creating a comprehensive workflow with menus for input, calibration, pre-processing, object detection and extraction, and analytics. An initial executable version has been delivered to the NASA PSI software team. This step is crucial as it establishes a functional framework for G-SPACE, enabling testing of the ATOM™ Toolbox on the NASA PSI website. Additionally, this initiates the integration process within the main NASA PSI website. Specific aspects being addressed include location on the NASA website, menu layout, definition of supporting software architecture, and interfacing with the G-SPACE main platform, as well as outlining maintenance and instruction requirements. The G-SPACE ATOM™ Toolbox will enable users access to a simple yet universal toolkit via the NASA PSI website. This will empower both existing and new Principal Investigators (PIs) by providing a standardized platform to enhance the initial stages of their analysis. Instead of valuable resources in creating individual analytic tools, researchers could utilize the G-SPACE ATOM™ Toolbox to streamline and accelerate data output, ensuring consistency and insightful analysis. This approach aims to boost the scientific preparedness of their investigations.

Bibliography Type:	Description: (Last Updated: 10/23/2024)
Abstracts for Journals and Proceedings	Cozmuta I, Osan R, Motil B, Taylor C. "An AI predictive platform for microgravity innovation." 23rd American Conference on Crystal Growth and Epitaxy (ACCGE-23) and 21st US Workshop on Organometallic Vapor Phase Epitaxy (OMVPE-21),Tucson, Arizona, August 13-18, 2023. Abstracts. 23rd American Conference on Crystal Growth and Epitaxy (ACCGE-23) and 21st US Workshop on Organometallic Vapor Phase Epitaxy (OMVPE-21),Tucson, Arizona, August 13-18, 2023. , Aug-2023
Abstracts for Journals and Proceedings	Cozmuta I, Osan R, Taylor C, Motil B, Bulugean G. "ATOM™ - an AI predictive platform for microgravity innovation. " 12th Annual International Space Station Research & Development Conference (ISSRDC), Seattle, WA, July 31-August 4, 2023. Abstracts. 12th Annual International Space Station Research & Development Conference (ISSRDC), Seattle, WA, July 31-August 4, 2023. , Jul-2023
Abstracts for Journals and Proceedings	Cozmuta I, Osan R, Taylor C, Motil B, Bulugean G. "Microgravity analytics for material and life science applications." ACS Fall 23 (Meeting of the American Chemical Society), San Francisco, CA, August 14-18, 2023. Abstracts. ACS Fall 23 (Meeting of the American Chemical Society), San Francisco, CA, August 14-18, 2023. , Aug-2023