Fiscal Year:	FY 2023	**Task Last Updated:**	FY 12/01/2022
PI Name:	Willey, Jeffrey S. Ph.D.		
Project Title:	A Technology to Measure Gait, Egress, and Locomotor Performance in Perturbed Environmental Conditions After Simulated Spaceflight		
Division Name:	Space Biology		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	None		
Human Research Program Risks:	None		
Space Biology Element:	(1) Animal Biology: Vertebrate		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Zip Code:	27157-0001	**Congressional District:**	5
Comments:	NOTE: PI formerly at Clemson University when NSBRI Postdoctoral Fellow Feb 2008-Oct 2010 (Ed., 12/18/2014)		
Project Type:	GROUND,New Investigation	**Solicitation / Funding Source:**	2018 Space Biology (ROSBio) NNH18ZTT001N-FG2. App D: Flight and Ground Space Biology Research
Start Date:	02/01/2021	**End Date:**	01/31/2024
No. of Post Docs:	0	**No. of PhD Degrees:**	0
No. of PhD Candidates:	1	**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 ARC
Contact Monitor:	Griko, Yuri	**Contact Phone:**	650-604-0519
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Flight Program:			
Flight Assignment:	NOTE: End date changed to 01/31/2024 per NSSC information (Ed., 1/4/23). NOTE: End date changed to 01/31/2023 per NSSC information (Ed., 2/1/22).		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Danelson, Kerry Ph.D. (Wake Forest University)		
Grant/Contract No.:	80NSSC21K0294		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Long-duration spaceflight is challenging for the many body parts that help us maintain normal movements and perform well, which include our bones, joints, vision, and brain. Astronauts must perform to the best of their abilities when they are traveling to a destination like the Moon or Mars, and when they reach the destination. During the travel to the destination, or on the surface of the planet/moon, astronauts could face dangerous situations that require rapid escape movements, or situations where the body could be in peril due to surroundings (like when climbing the rough terrain of a mountain or into a valley). If an astronaut is not performing well due to altered visual performance, but also has damaged bones due to low gravity or radiation, the astronaut could be at risk of catastrophic joint tears or bone breaks while exploring uneven/dangerous terrains, or during a required rapid escape into or out of a spacecraft. Our laboratory has measured that performance is altered in rodents after ~35 days in orbit on the International Space Station. However, these measurements were taken on a treadmill moving forward at a constant speed. This does not represent the dangerous terrain of the Moon or Mars, or other rapid movements astronauts would face during spaceflight. Thus our intent is to develop and fabricate a method to better reflect locomotor performance in rodent models over uneven and dangerous lunar/Martian surfaces in order to best assess how combined spaceflight hazards (e.g, microgravity and radiation) cause deficits in astronaut performance, measure time to recovery, and identify countermeasures. We will create a platform on which sits our treadmill that can measure mouse and rat performance. However, the platform can move (one movable portion under each corner support of the treadmill) in a manner that can reflect uneven terrain or a rapid escape motion. Then we can measure how the animals that have previously been exposed to spaceflight conditions (like reduced gravity or radiation) respond. This platform and performance measurement device can then be used to test ways to maximize performance, and thus improve the technologies and approaches used during successful crewed space exploration.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	This technology will permit us to measure how stability is affected after actual and simulated spaceflight, using rodents. Instability is a common biomedical problem that results from multiple conditions, including central nervous system diseases or injury, after orthopaedic procedures or injuries, after cancer treatment, among others. Maintaining stablilty while walking is essential for maintaining a patient's quality of life. Thus this technology will help us study the extent and mechanisms leading to instability in rodents models for these biomedical conditions, and then find ways to improve stability while walking or running.
Task Progress:	The adjunct frame was constructed and the DigiGait™ gait system was mounted within the unit, which permits movement in multiple axes as the frame functions as a "gyroscope". The motor control was programmed in the Arduino Integrated Development Environment (IDE) and uploaded to an Arduino Uno circuit board with two BTS7960 motor drivers that control roll and pitch of the frame, and thus the DigiGait inside the frame. The Arduino IDE was selected because it is an open source software and Arduino electrical components are readily available. To effectively move the DigiGait within the frame, as it weighs several hundred pounds, we sourced larger capacity 12V DC motors manufactured by Leeson. These motors are designed for large mechanical loads and hard-to-start applications as they generate 1 horsepower and 35 in-lb of full-load torque. At their max, these motors will draw 80 amps, which required us to source a marine battery as a power supply. We tested the functionality of the Leeson motors using a Dart speed control system. This control uses a mechanical relay switch to control motor direction and a potentiometer to control motor speed. The benefit of this system is that it allows us to test motor response and determine the appropriate time needed to generate the desired displacements of the DigiGait™ treadmill surface. We tested mice on the frame, moving at 17cm/s. The frame had the capacity to move the DigiGait as expected, and while forward linear movements were observed to be perturbed, the mice did recover linear walking as expected. We will then analyze these movements and animal postural patterns from images captured by the DigiGait in order to assess which parameters are important in determining performance deficits that can be measured by perturbing linear motion using the adjunct frame.
Bibliography Type:	Description: (Last Updated: 04/06/2023)
Abstracts for Journals and Proceedings	Willey JS, Polich JG, Hamby JA, Moore JE, Danelson KA. "A technology to measure rodent gait and performance while moving across a perturbed surface to better simulate spaceflight conditions." 38th Annual Meeting of the American Society for Gravitational and Space Research, Houston, TX, November 9-12, 2022. Abstracts. 38th Annual Meeting of the American Society for Gravitational and Space Research, Houston, TX, November 9-12, 2022. , Nov-2022