Fiscal Year:	FY 2020	**Task Last Updated:**	FY 07/23/2020
PI Name:	Gao, Wei Ph.D.		
Project Title:	A Multimodal Wearable System for Deep Space Monitoring of Stress and Anxiety		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:	TRISH--TRISH		
Joint Agency Name:		**TechPort:**	Yes
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:	91125	**Congressional District:**	27
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	2020 TRISH BRASH1901: Translational Research Institute for Space Health (TRISH) Biomedical Research Advances for Space Health
Start Date:	04/01/2020	**End Date:**	03/31/2022
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No. of PhD Candidates:		**No. of Master' Degrees:**	
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COI Name (Institution):	Yue, Yisong Ph.D. (California Institute of Technology)		
Grant/Contract No.:	NNX16AO69A-T0501		
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Task Description:	The goal of this research is to develop a holistic hardware/software solution based on a multimodal wearable sensing platform to achieve dynamic deep space stress and anxiety assessment. High levels of stress, caused by extreme working environments, can significantly affect the performance of NASA astronauts. Early detection and classification of the severity of stress allow for timely intervention which is crucial for improving the performance of the astronauts. However, current stress assessment approaches are largely based on questionnaires, which can be subjective. Despite the high demand for dynamic performance assessment using wearable devices, commercially available health monitors are only capable of tracking an individual's physical activities and vital signs, failing to provide insightful information about the user's health state at molecular levels. In this regard, sweat could serve as an excellent candidate for non-invasive stress response monitoring as it contains rich physiological information. Our hypothesis is that sweat analyte levels monitored continuously along with the key vital signs, when coupled with machine learning approach, will provide accurate and dynamic stress and anxiety assessment. Our approach is to simultaneously monitor the molecular analytes in human sweat including stress hormones (i.e., cortisol, adrenaline, and noradrenaline), glucose, lactate, sodium, potassium, pH, sweat rate, and key vital signs (i.e., skin temperature, blood pressure, heart rate, and heart rate viability) using the wearable multimodal sensing platform. Based on a combination of the physical/molecular data and machine learning model, a more comprehensive stress assessment system with significantly higher accuracy and robustness can be achieved. This project could provide crucial insight into the stress level of NASA astronauts and result in significant benefits by improving human performance through timely intervention. To accomplish our goal, we propose the following objectives: (1) Develop a multimodal wearable sensor system for real-time monitoring of physical and molecular parameters. By adapting our existing physical and sweat sensing technologies, we will develop a multimodal platform for both sweat and vital sign analysis. The wearable system will wirelessly communicate with a custom designed user interface. (2) Conduct human trials on dynamic stress response assessment using the multimodal sensing system in both laboratory and real-life settings. We will conduct multiple stress-inducing training sessions to collect large sets of physical and molecular data. (3) Develop the signal processing software and determine the predictive algorithm(s) of stress and anxiety via machine learning. Sensor fusion algorithms will be used on the multimodal signals to extract the key features as well as increase the accuracy of the monitoring process. Stress and anxiety classification algorithms will analyze the derived features to detect stress levels. The combination of the multimodal system (hardware), data processing and machine learning model (software) could provide an attractive solution for accurate deep space stress assessment.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	
Task Progress:	New project for FY2020.
Bibliography Type:	Description: (Last Updated: 07/11/2023)