Fiscal Year:	FY 2009	**Task Last Updated:**	FY 06/05/2009
PI Name:	Dinges, David F. Ph.D.		
Project Title:	Optical Computer Recognition of Stress, Affect and Fatigue during Performance in Spaceflight		
Division Name:	Human Research		
Program/Discipline:	NSBRI		
Program/Discipline--Element/Subdiscipline:	NSBRI--Neurobehavioral and Psychosocial Factors Team		
Joint Agency Name:		**TechPort:**	Yes
Human Research Program Elements:	(1) **BHP**:Behavioral Health & Performance (archival in 2017)		
Human Research Program Risks:	(1) **BMed**:Risk of Adverse Cognitive or Behavioral Conditions and Psychiatric Disorders		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Zip Code:	19104-4209	**Congressional District:**	2
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	2007 Crew Health NNJ07ZSA002N
Start Date:	05/01/2008	**End Date:**	04/30/2012
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:	26	**Monitoring Center:**	NSBRI
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Banks, Siobhan (University of Pennsylvania Health System) Metaxas, Dimitri (Rutgers University)		
Grant/Contract No.:	NCC 9-58-NBPF01601		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Astronauts must maintain high-level performance while experiencing demanding workload and work schedules, extreme environmental risks, and psychosocial stressors in space (e.g., isolation, confinement). Stress, negative emotions and fatigue can jeopardize their cognitive performance and neurobehavioral status. The proposed research will deliver an objective, unobtrusive, computational model-based tracker of the human face that validly and reliably identifies when astronauts are experiencing stress, emotion and fatigue at levels that compromise performance in space. This optical computer recognition (OCR) system will provide feedback to them for autonomous selection of countermeasures for stress, depression and fatigue. The project will be accomplished through collaborative efforts of Dr. David Dinges (Unit for Experimental Psychiatry) at the University of Pennsylvania School of Medicine, and Dr. Dimitris Metaxas (Computational Biomedicine Imaging and Modeling Center) at Rutgers University. The project has four specific aims: (1) Create an OCR system capable of monitoring facial displays of specific emotions (i.e. angry, happy and sad). (2) Improve our current OCR system's ability to detect facial expressions of high versus low performance-induced stress. (3) Develop OCR algorithms to identify fatigue due to sleep loss based on slow eyelid closures (PERCLOS). (4) Test the technical feasibility of data acquisition and reliability of the advanced OCR system in spaceflight analogs that contain neurobehavioral stressors relevant to spaceflight (e.g., NEEMO). The project has primary relevance to strategic goals of the NSBRI Neurobehavioral and Psychosocial Factors (NBPF) Team. It addresses a high priority gap identified by the NASA SAT, BHP, and NSBRI NBPF area, and specifically targets questions 25d,c,g,h of Bioastronautics Roadmap Risk Area 25 (Human Performance Failure Due to Neurobehavioral Problems), and question 27d in Risk Area 27 (Human Performance Failure Due to Sleep Loss and Circadian Rhythm Problems).
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	The study focuses on the ability of an unobtrusive, automated optical technology to detect psychological stress, emotion and fatigue during operational performance. The knowledge gained has the potential to identify an objective, unobtrusive, automated method for the recognition, monitoring, and management of the risks of neurobehavioral dysfunction in affect and alertness in space flight and in many Earth-based safety-sensitive occupations, such as transportation workers (e.g., truck drivers, train conductors, airline pilots); operators in safety-sensitive industries (e.g., power plant control rooms); and military personnel.
Task Progress:	The overarching goal of the project is to further develop and validate computerized system that unobtrusively detects stress, emotion and fatigue during space flight. We previously completed development of an optical algorithm for real-time dynamic tracking of the face using a deformable model-based tracker and Active Shape Modeling that reliably discriminates low from high stress by monitoring facial expressions. To overcome the limitations of previous optical tracking techniques, Metaxas and colleagues developed a formal framework for the integration of edge detection and optical flow into a deformable model framework and applied it to facial shape and motion estimation. This method used a single camera to track the shape of the face and its movement in 3-dimensional space, and it created a deformable model, incorporating optical flow (an approximation of the motion of objects within a visual representation) into the model as a constraint. We have made several other new developments to the OCR system: (1) the technique was validated with the use only one camera, where the previous method required two; (2) we improved tracking by using a manifold of faces that helped automatically track the face as the head moves; (3) we added the use of Conditional Random Fields in addition to Hidden Markov Modeling, to the algorithm which improved its computational efficiency; and (4) GABOR filtering (used for edge detection in image analysis) was incorporated into the ASM algorithm to track changes in facial texture, allowing it to identify features (e.g., furrowed brow). In the first year of the current project we have begun expanding the algorithm to recognize facial expressions of emotion and behavioral indicators of excessive sleepiness (through slow eyelid closures). We are also continuing our work to improve the system's ability to correctly identify stress. Preliminary data confirm that the experimental procedures reliably induce stress, emotion and fatigue. In this first year we designed and implemented the two experiments we proposed (one on emotion detection and one on stress and fatigue detection. Twenty healthy subjects have completed the two experiments (N=9 in Experiment 1 and N=11 in Experiment 2). We are using these data to expand and improve the current OCR algorithm.
Bibliography Type:	Description: (Last Updated: 04/24/2024)