Fiscal Year:	FY 2010	**Task Last Updated:**	FY 05/21/2010
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:	4	**No. of Master' Degrees:**	0
No. of Master's Candidates:	0	**No. of Bachelor's Degrees:**	21
No. of Bachelor's Candidates:	24	**Monitoring Center:**	NSBRI
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Metaxas, Dimitris (Rutgers University) Goel, Namni (University of Pennsylvania)		
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 is developing and validating an objective, unobtrusive, computational model-based tracker of the human face that 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 is being 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. Two major laboratory experiments for OCR development and validation are underway. The project is 50% complete. To date, half of the total number of subjects required to complete the two experiments have been studied.
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:	In the second year of the current project we have continued to expand the OCR 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. During the second year, we have continued collecting data for the two experiments we proposed (one on emotion recognition and one on stress and fatigue detection). Twenty healthy subjects have completed the two experiments (n=11 in Experiment 1 and n=9 in Experiment 2). We are using these data to expand and improve the current OCR algorithm. Together with data acquired in year 1 on n=20 other subjects, a total of n=40 subjects have been studied to date (i.e., n=20 in each of the 2 experiments). In Experiment 1 (emotion recognition), 15 hours of footage for facial emotional analysis was collected. Subjective emotional questionnaires also were administered to all subjects. In Experiment 2 (stress and fatigue detection), 180 hours of digitally recorded high definition footage was collected capturing the faces of subjects during performance of the Psychomotor Vigilance Task (PVT). Facelab data and PVT reaction times were simultaneously recorded throughout these test bouts, which were administered every 2 hours over the course of two consecutive days. 3 hours of footage was recorded for facial emotional analysis and 20 hours of footage also was collected for stress analysis. In addition, data from neuropsychological tasks, personality questionnaires, and subjective emotional rating scales were obtained from all subjects. With regard to the stress-related hormone analysis in Experiment 2, a total of 45 saliva samples were collected during stress-inducing tasks (5 saliva samples per subject). EEG/EKG data were also collected during these stress-inducing tasks.
Bibliography Type:	Description: (Last Updated: 04/24/2024)
Abstracts for Journals and Proceedings	Dinges DF, Metaxas D, Minkel JD, Lee C, Caruso H, Banks S, McGlinchey EL. "Optical computer recognition of the face to monitor stress, emotion and fatigue in space flight." 80th Annual Aerospace Medical Association Scientific Meeting, Los Angeles, CA, May 4, 2009. Aviation, Space, and Environmental Medicine. 2009 Mar;80(3):224. , Mar-2009
Abstracts for Journals and Proceedings	Dinges DF, Metaxas DN, Minkel JD, Banks S, Michael N. "Optical computer recognition of behavioral stress in space flight." NASA Human Research Program Investigators' Workshop, League City, TX, February 3, 2009. NASA Human Research Program Investigators' Workshop, Abstract Book, February 2009. , Feb-2009
Articles in Peer-reviewed Journals	Lim J, Wu WC, Wang J, Detre JA, Dinges DF, Rao H. "Imaging brain fatigue from sustained mental workload: an ASL perfusion study of the time-on-task effect." Neuroimage. 2010 Feb 15;49(4):3426-35. http://dx.doi.org/10.1016/j.neuroimage.2009.11.020 ; PMID: 19925871 , Feb-2010
Awards	Dinges D. "Raymond F. Longacre Award for Outstanding Accomplishment in the Psychological and Psychiatric Aspects of Aerospace Medicine, Aerospace Medical Association, May 2009." May-2009
Books/Book Chapters	Rathjen T, Whitmore M, McGuire K, Goel N, Dinges DF, Tvaryanas AP, Zehner G, Hudson J, Dismukes RK, Musson DM. "An introduction to human factors in aerospace." in "Fundamentals of Aerospace Medicine (4th edition)." Ed. J.R. Davis et al. Philadelphia : Lippincott Williams & Wilkins, 2008. p. 491-515., Dec-2008
Dissertations and Theses	Minkel J. "Affective consequences of sleep deprivation." Dissertation, University of Pennsylvania, May 2009. , May-2009