Fiscal Year:	FY 2007	**Task Last Updated:**	FY 01/08/2007
PI Name:	Aoki, Hirofumi Ph.D.		
Project Title:	Virtual Reality-Based Pre-Flight Astronaut 3D Navigation Training		
Division Name:	Human Research		
Program/Discipline:	NSBRI Teams		
Program/Discipline--Element/Subdiscipline:	NSBRI Teams--Sensorimotor Adaptation Team		
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:	02139	**Congressional District:**	8
Comments:			
Project Type:	Ground	**Solicitation / Funding Source:**	2005 NSBRI-RFP-05-01 Postdoctoral Fellowships
Start Date:	10/01/2005	**End Date:**	10/01/2007
No. of Post Docs:	1	**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:**	NSBRI
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:	NOTE: changed end date to accommodate NSBRI final report submission (jp 5/08)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Oman, Charles (MENTOR: Massachusetts Institute of Technology)		
Grant/Contract No.:	NCC 9-58-PF00902		
Performance Goal No.:			
Performance Goal Text:			
	POSTDOCTORAL FELLOWSHIP: The goal of this sensorimotor/human factors project is to develop a virtual reality (VR) based training method for astronauts aboard International Space Station (ISS) or a Mars mission vehicle as a countermeasure of inflight spatial disorientation and navigation. These problems have been frequently reported by crews of Space Shuttle, Mir, and ISS as complicating responses to emergencies. The 3D architecture and inconsistency of the visual vertical of adjacent quarters and modules, combined with the limited visual experience of crewmembers is the major cause of the problem, identified as a significant risk by NASA. Astronauts normally see the interior of a spacecraft from a variety of body orientations and viewpoints that cannot be simulated on the ground. It requires cognitive skills to interrelate cues perceived in a body centered (egocentric) frame of reference built up directly through navigation and also in an overall		

Task Description:	(allocentric) frame of reference defined by the spacecraft. Astronauts can either learn this interrelationship inflight, or develop the required cognitive knowledge prior to flight via VR simulation. This study intends to clarify whether VR training can help to integrate egocentric and allocentric frame of reference and to understand retention, learning, and the limitations of 3D human spatial orientation and navigation for long-term training. In the experiment, two groups (Control, Treatment) of subjects explore a virtual ISS while wearing a head-mounted display with head tracker. In Training, two groups are trained in a different manner but have the same total training time. The control group learns each module separately, while the treatment group learns the whole ISS at once. A virtual 3D space station model is also available to the treatment group. In Testing, the subjects are told their destination and are asked to point there. The visibility is sometimes obstructed by smoke. Upon arrival at the destination they point back to the start point and reproduce the experienced route using a virtual scale model. Correct answers for the pointing and route reproduction tasks are provided as feedback only for the treatment group. Testing is also done 1, 7 and 30 days later, where only the treatment group is told error types they made in the previous testing. The treatment group should show quantitatively superior spatial knowledge and navigation skills. The results should help define procedures for actual astronaut preflight spatial disorientation and navigation training.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Results support deep understanding in human from the viewpoint of brain and cognitive science. Our results also pertain to environmental and architectural design and pre/post-occupancy evaluation of buildings, underground, and cities. The simulation tool could be used for other profession such as firefighter and submariners, as well as occupant of high-story buildings.
Task Progress:	1. Updating the space station 3D model The space station 3D model we have made for the previous experiments was similar to ISS, and consisted of seven rectangular modules (Destiny, JEM, Columbus, CAM, Zvezda (Service Module), and Soyuz), three cubic modules (Node1, 2, and a Russian node), and a PMA. The pictures of the ISS modules in orbit, ground mockups, and illustrations were used for the interior texture. The module size, shape, and location were, however, modified for experimental purposes. Now we are developing the 3D models to be closer to the ISS. With help of Drs. Edna Fiedler of NSBRI and Barbara Woolford of JSC, we have better ISS interior/hardware photos. A better 3D model of ISS was provided by Jeffery Murch and Patrick Troutman at NASA Langley Research Center. Four new functions have been installed into the VR tool for the next experiment. i) Outside-view map ii) See-through (virtual X-ray vision) function iii) Background sound iv) Fog on/off 2. ISS emergency training We observed ISS emergency training for Expedition 15 crewmembers on July 14, 2006. The training was performed by ISS Environmental Control Group (JSC-DT4) led by David Hudson. They simulated various situations such as decompression, toxic gas leak, and fire with smoke. Obviously, due to the physical conditions of the mockup trainers in Building 9 (not the same as the flight configuration), the training focus on the procedures at particular places in a module and less on inter-module activities. During and after the NSBRI's Summer Institute program, Dr. Aoki discussed with them how to define and incorporate a reasonable scenario involving 3D intermodule spatial activities into the training tool we have been developing. We are working to finalize some of the scenarios and include them in the tool. As soon as a scenario is installed in the tool, it will be evaluated by Hudson's group and hopefully ultimately by some astronauts. 3. A portable immersive VR system was developed with a laptop, a lightweight HMD and a 6 DOF head motion sensor. This system could be run only from laptop battery power supply. This can be used for demonstration and future experiments on an air-bearing bed and/or parabolic flight.
Bibliography Type:	Description: (Last Updated: 09/11/2017)
Abstracts for Journals and Proceedings	Aoki H, Oman CM, Natapoff A, Liu A. "The effect of the configuration, frame of reference, and spatial ability on spatial orientation during virtual 3-dimensional navigation training." Seventh Symposium on the Role of Vestibular Organs in Space Exploration, ESTEC, Noordwijk, the Netherlands, June 7-9, 2006. Submitted for Publication, June 2006. , Jun-2006
Abstracts for Journals and Proceedings	Oman CM, Benveniste D, Buckland DA, Aoki H, Liu AM, Natapoff A, Kozhevnikov M. "Incongruent spacecraft module visual verticals affect spatial task performance." Seventh Symposium on the Role of Vestibular Organs in Space Exploration, ESTEC, Noordwijk, the Netherlands, June 7-9, 2006. Submitted for publication, June 2006. , Jun-2006
Abstracts for Journals and Proceedings	Oman CM, Benveniste D, Buckland DA, Aoki H, Liu AM, Natapoff A, Kozhevnikov M. "Spacecraft module visual verticals and individual spatial learning abilities determine 3D spatial task performance." 77th Aerospace Medical Association (ASMA) meeting, Orlando, FL, May 15-18, 2006. Aviat Space Environ Med. 2006 Mar;77(3):349. Abstract #543. , Mar-2006
Abstracts for Journals and Proceedings	Oman CM, Benveniste D, Buckland DA, Aoki H, Liu AM, Natapoff A. "Spacecraft module visual verticals and training affect spatial task performance." Habitation 2006 conference, Orlando, FL, February 5-8, 2006. Habitation. 2006;10(3-4):202-3. , Feb-2006