Andrew M. Liu

Work Address

Massachusetts Institute of Technology
77 Massachusetts Avenue, 37-219
Cambridge, MA 02139-4307
(617) 253–7758
amliu@mit.edu

Home Address

53 Kingswood Rd.
Auburndale, MA 02466
(617) 332–7974

Experience

MIT Dept. of Aeronautics & Astronautics, Cambridge, MA — 2008–present
Research Scientist, Human Systems Laboratory (Man Vehicle Laboratory).
Research on spatial learning and navigation in virtual reality/augmented reality, microgravity and teleoperation. Research on alertness monitoring of locomotive engineers and fatigue countermeasures. Software development and operations for Mars Oxygen ISRU Experiment (MOXIE) on the Mars2020 rover.

MIT Kavli Institute for Astrophys. & Space Res., Cambridge, MA — 1999–2008
Research Scientist, Man Vehicle Laboratory.

Nissan Cambridge Basic Research, Cambridge, MA — 1999–2001
Visiting Scientist.

Nissan Cambridge Basic Research, Cambridge, MA — 1993–1999
Staff Research Scientist.
Developed dynamic models of human behavior to recognize driver intentions as the basis of a system to improve driver interaction with automated vehicle systems. Principal developer of the CBR driving simulator.

NASA Ames Research Center, Moffett Field, CA — 1992-93
Consultant, NASA Contact: Dr. Robert Welch
Established a virtual reality laboratory for the experimental study of the human interface with virtual environments.

University of California, Berkeley, CA — 1992-93
Dept. of Visual Science, Post-doctoral Fellow with Prof. Lawrence Stark
Studied human visual search & presence in virtual environments.

University of California, Berkeley, CA — 1988–92
Research Assistant with Prof. Lawrence Stark, Dept. of Vision Science.
Studied perceptual constraints at the human-machine interface for telerobotic tasks.

University of California, San Francisco, CA — 1987
Research Assistant with Prof. David Copenhagen, Dept. of Ophthalmology.
Developed a preliminary protocol for measuring glutamate uptake in fish retina.

The Johns Hopkins University, Baltimore, MD — 1985–86
Research Assistant with Prof. Aleksander Popel, Dept. of Biomedical Engineering.
Mathematical modeling of vascular networks in muscle tissue.

Education   **University of California**, Berkeley and San Francisco, CA
Ph.D, Bioengineering, 1993
Thesis title: "Depth Cues for Telerobotic Tasks in Virtual Environments"

The Johns Hopkins University, Baltimore, MD
B.S. Biomedical Engineering, 1986
General Honors, Departmental Honors

Grants and Awards

Co-Investigator, "Responsive multimodal human-automation communication for augmenting human situation awareness in nominal and off-nominal scenarios", National Aeronautics and Space Administration (2019-2023)

Co-Investigator, "Augmented Reality for Railroad Operations Using Head-up Displays", US Dept. of Transportation, Federal Railroad Administration (2018-2021)

Co-Investigator, "Design and Evaluation of a Robust Manual Locomotive Operating Mode", GE Research Center/US Dept. of Transportation, Federal Railroad Administration (2018-2021)

Co-Investigator, "External Perception for Locomotives (ExP-L)", Aurora Flight Sciences/US Dept. of Transportation, Federal Railroad Administration (2018-2019)

Co-Investigator, "Monitoring Engineer Fatigue (MEFA) System", Aurora Flight Sciences/US Dept. of Transportation, Federal Railroad Administration (2018-2019)

Co-Investigator, "Design and Implementation of a Heads-Up Display for the Cab Technology Integration Laboratory", US Dept. of Transportation, Federal Railroad Administration (2016-2017)

Co-Investigator, "Design and Evaluation of Automated Electronic Checklists for Robotics Operations", National Aeronautics and Space Administration (2015-2017)

Co-Investigator, "Drowsiness Mitigation via Ambient Lighting", Ford Motor Company (2014-2016)

Co-Investigator, "Customized Refresher and Just-In-Time Training for Long-Duration Spaceflight Crews", National Space Biomedical Research Institute (2014-2017)

Co-Investigator, "Investigation of New Roles for Humans and Automation in Next-Generation Rail Operations", Federal Railroad Administration (2014-2016)

Co-Investigator, "Development and Evaluation of a High Speed Rail Scheduling and HUD Display", US Dept. of Transportation, Federal Railroad Administration (2011-2013)

Co-Investigator, "Automation and HSI Complexity in Advanced Reactors", US Nuclear Regulatory Commission (2011-2012)

Co-Investigator, "Validation of Assessment Tests and Countermeasures for Detecting and Mitigating Changes in Cognitive Function during Robotics Operations", National Space Biomedical Research Institute (2009-2013)

Co-Investigator, "Sensorimotor interaction with vehicle displays and controls to enhance human-machine cooperation during precision lunar landing", National Space Biomedical Research Institute (2008-2009)

Co-Investigator, "Advanced Displays for Efficient Training of Robotic Systems, National Space Biomedical Research Institute (2007-11)

Co-Investigator, "Efficient Individualized Teleoperation Training via Spatial Ability Assessment, National Space Biomedical Research Institute (2007)

Co-Investigator, "Development of LEGO-based Curricula for Sciences and Technology Education", Newton Schools Foundation (2006)

Co-Investigator, "Visual Orientation, Navigation, and Spatial Memory Countermeasures",

National Space Biomedical Research Instutite (2004)
Co-Investigator, "Human Visual Orientation and Spatial Memory: Mechanisms and Countermeasures", National Space Biomedical Research Institute (2001)
NRC Research Associateship at NASA-Ames Research Center (1993)
Student Travel Grant, Society for Information Display (1992)

Fred Burggraf Award, Transportation Research Board (2001)
NIH Systems and Integrative Biology/Bioengineering Traineeship (1986–88)
General Honors, Department Honors, Dept. of Biomedical Engineering, The Johns Hopkins University, Baltimore, MD (1986)
Student Research Internship, Oak Ridge Associated Universities (1984)

Professional Activities

Advisory Board, "Holistic Human Factors and System Design of Adaptive Cooperative Human-Machine Systems (HoliDes)", European Union, 2014-2017.

National Academy of Science/Institute of Medicine Workshop to Review the NASA Evidence Reports on Human Health Risks, Washington, DC, July 17, 2014

Scientific Advisory Board, "Integrated Human Modelling and Simulation to support Human Error Risk Analysis of Partially Autonomous Driver Assistance Systems (ISi-PADAS)", European Union, 2009-2011.

Advisory Committee, "The Use of Virtual Reality for the Assessment of Driving Skills Following Acquired Brain Injury," National Institute on Disability and Rehabilitation, 2000-2004

Program Committee, IEEE Virtual Reality Conference (1995–2004).
(Originally IEEE Virtual Reality Annual International Symposium)

Review Panel, "Collaborative Telemedicine in Virtual Environments," New Jersey Commission on Science and Technology, December 2000

Organizing Committee, Vision in Vehicles 8 Conference, 1999.

Organizer and speaker, CBR Workshop on Human Interaction with Automated Systems, Cambridge, MA, June 1, 1998.

Session organizer and co-chair, "Human Perception, Performance, and Presence in Virtual Environments." 1992 SPIE Conference on Human Vision, Visual Processing and Digital Display, San Jose, CA.

Ad hoc reviewer:
National Science Foundation, Transportation Research Board, IEEE Transactions on Systems, Man, & Cybernetics, Pts. A, B., Human Factors, Presence: Teleoperators and Virtual Environments, IEEE Computer Graphics & Applications, Perception & Psychophysics, Behavioral Research Methods, Institute of Medicine, International Journal of Human-Computer Studies, IEEE Transactions on Intelligent Transportation Systems, IEEE Intelligent Transportation Systems Magazine, Spatial Cognition and Computation, Transportation Research, Part F: Traffic Psychology and Behaviour, IET Intelligent Transportation

Systems, Human Factors and Ergonomics Society Annual Meeting, ACM CHI Conference, Intl. Conference on Vision in Vehicles, IEEE Intl. Conference on Robotics & Automation, 1996 ACM Virtual Reality Software & Technology Conference

Society Membership:
    IEEE: Systems, Man, and Cybernetics Society
    Human Factors and Ergonomics Society

Teaching Experience
Massachusetts Institute of Technology
    16.400 *Human Factors*, Guest Lecturer (2001, 2005-2015)
    16.438 *Space Biomedical Engineering*, Guest Lecturer
    16.S26 *Modern Space Science and Engineering*, Guest Lecturer
Boston University
    CNS730 *Models of Visual Perception*, Guest Lecturer (1998)
University of California, Berkeley
    ME210 *Telerobotics and Biological Control*, Instructor (1992)
    ME210 *Telerobotics and Biological Control*, Graduate Instructor, (1987–91)

Supervised over 50 students in the MIT Undergraduate Research Opportunities Program

Publications (Journals)

J.D. Brooks, N. Subrahmaniyan, B.W. Miller, A.M. Liu, H. Groshong, C. Oman, and P. Houpt. (2017) "A Survey of Future Railroad Operations and the Role of Automation." *Transportation Research Record: Journal of the Transportation Research Board*, 2608:1018, DOI: 10.3141/2608-02

A.M. Liu, C.M. Oman, R. Galvan, and A. Natapoff. (2012) "Predicting Space Telerobotic Operator Performance from Human Spatial Ability Assessment." *Acta Astronautica*, 92: 38-47 online: http://dx.doi.org/10.1016/j.actaastro.2012.04.0004

C.T. Oravetz, L.R. Young, and A.M. Liu. (2009) "Slope, distance, and height estimation of lunar and lunar-like terrain in a virtual environment." *Gravitational and Space Biology*, 22(2): 57-66.

J.T. Richards, C.M. Oman, W.L. Shebilske, A.C. Beall, A. Liu, and A. Natapoff. (2003) "Training, Transfer and Retention of Three-Dimensional Spatial Memory in Virtual Environments." *Journal of Vestibular Research*, 12(5-6): 223-238.

D. Salvucci and A. Liu. (2002) "The Time Course of a Lane Change: Driver Control and Eye Movement Behavior." *Transportation Research, Part F*, 5(2): 123-132.

D. Salvucci, E. Boer, and A. Liu (2001) "Towards an Integrated Model of Driver Behavior in a Cognitive Architecture." *Transportation Research Record*, 1779: 9-16.

A. Pentland and A. Liu. (1999) " Modeling and prediction of human behavior." *Neural Computation*, 11:229-242.

A. Liu and A. Pentland. (1997) "Recognizing Driver Intentions with Hidden Markov Models." *Nissan Technical Review*, 41:53-56.

R. B. Welch, T. T. Blackmon, A. Liu, B. A. Mellers, and L. Stark. (1996) "The Effect of Pictorial Realism, Delay of Visual Feedback, and Observer Interactivity on the Subjective Sense of Presence in a Virtual Environment." *Presence: Teleoperators and Virtual Environments*, 5(3):263-273. (Alphabetical listing of authors after first author)

A. Liu and A. P. Pentland. (1996) "Detection of Unexpected Motion While Driving: From Psychophysics to Real Life via Virtual Environments." *Presence: Teleoperators and Virtual Environments*, 5(2):163-172.

A. Liu, G. Tharp, L. French, S. Lai, and L. Stark. (1993) "Some of What One Needs to Know About Helmet-Mounted Display Performance." *IEEE Transactions on Robotics & Automation*, 9(5):638-648.

A. Liu, G. Tharp, M. Hirose, and L. Stark. (1992) "Visual Factors Affecting Human Operator Performance with a Helmet Mounted Display." *In SAE Transactions - Journal of Aerospace*, vol. 100, pp. 976-84, Society of Automotive Engineers.

A. Liu and L. Stark. (1991) "The Effect of Monocular Blur on Simulated Telerobotic Manipulation." *IEEE Transactions on Robotics & Automation*, 7(3): 372-376.

A.S. Popel, A. Liu, B. Dawant, A. Koller, and P.C. Johnson. (1988) "Distribution of vascular resistance in terminal arteriolar networks of cat sartorius muscle." *Am. J. Physiol.*, 254 (Heart Circ. Physiol. 23): H1149-H1156.

M.L. Ellsworth, A. Liu, B. Dawant, A.S. Popel, and R.N. Pittman. (1987) "Analysis of Vascular Pattern and Dimension in Arteriolar Networks of Retractor Muscle in Young Hamsters." *Microvasc. Res.*, 34: 168-183.

A. Koller, B. Dawant, A. Liu, A.S. Popel, and P.C. Johnson. (1987) "Quantitative analysis of arteriolar network architecture in cat sartorius muscle." *Am. J. Physiol.*, 253(Heart Circ. Physiol. 22): H1154-H1164.

Publications (Chapters)

A.M. Liu. (2011) "Modelling Differences in Behavior Between and Within Drivers." In C. Cacciabue, M. Hjalmdahl, A. Ludtke and C. Riccioli, Eds., *Human Modelling in Assisted Transportation*, Milan: Springer-Verlag, pp. 15-22.

A. Liu. (1998) "What the Driver's Eye Tells the Car's Brain." In G.J. Underwood, Ed., *Eye Guidance During Reading and Scene Perception*, Oxford: Elsevier, pp. 431-452.

Publications (Refereed)

H. Weiss, A. Liu, and L. Stirling (2021) "Opportunities for Augmented Reality and Wearables to Support Humans in Space." To appear in *Proc. of the ACM Annual Conference on Human Factors in Computing Systems (CHI), SpaceCHI 2021 workshop*.

R. Grice, D. Fisher, M. Isaacs, and A.Liu (2020) "Multimodal Display to Reduce Distraction in Locomotive Engineers." *Proc. of the 2020 HFES 64th International Annual Meeting*, 64(1):2025-2029.

J. E. Todd, A. Liu, and L. Stirling (2020) "Investigation of augmented reality in enabling telerobotic on-orbit inspection of spacecraft." *Proc. of the 2020 International Conference on Environmental Systems*, Paper Number ICES-2020-538.

A.M. Liu (2019) "Measuring the Time Course of Engineer Workload During Automation Mode Transitions." *Proc. of the Human Factors and Ergonomics Society 2019 International Annual Meeting*, Seattle, WA.

A.M. Liu, C.M. Oman, and K. Voelbel (2017) "Development and Evaluation of a Moving Map Display for Rail Applications." Technical Report No. DOT/FRA/ORD-17/24. U.S. Department of Transportation, Federal Railroad Administration. https://www.fra.dot.gov/eLib/Details/L19183

Y.E. Yang, A. Liu, D. Dori, R. Galvan-Garza, and C. Oman. (2017) "Task Analysis and Interface Design Using Object-Process Methodology." *Aerospace Medical Association 88th Annual Scientific Meeting*, Denver, CO, Apr 30-May 4.

J.D. Brooks, N. Subrahmaniyan, B.W. Miller, A.M. Liu, H. Groshong, C. Oman, and P. Houpt. (2017) "A Survey of Future Railroad Operations and the Role of Automation." *2017 Meeting of the Transportation Research Board*, Washington, DC.

J.D. Brooks, N. Subrahmaniyan, B.W. Miller, A.M. Liu, H. Groshong, C. Oman, and P. Houpt. (2017) "Human Centered Automation Design: An Application to In-Cab Rail Technology." *2017 Meeting of the Transportation Research Board*, Washington, DC.

J. Young, M. Isaacs, G. Newman, C. Schneider, A. Krishnan, C. Nichols, A. Liu, T.M. Zafian, J. Zhang, G. Melnik, M. Romoser, G. Elsmore, and D. Fisher. (2015) "Moving

Map Displays: Using CTIL and Eye Tracking Technologies to Measure Operator Performance in Locomotive Cabs." *2015 Road Safety & Simulation International Conference*, Orlando, FL, Oct 6-8.

R.G. Galvan, A. Liu, M. Rueger, E. Flynn-Evans, A. Natapoff, S. Lockley, and C. Oman (2013) Validation of assessment tests and countermeasures for detecting and mitigating changes in cognitive function due to fatigue during telerobotics operations. *Aviation, Space and Environmental Medicine*, 84(4): 413.

K.M. Thornburg, H.P.M. Peterse, and A.M. Liu (2012) "Operator Performance in Long Duration Control Operations: Switching from Low to High Task Load." *Proc. of the Human Factors and Ergonomics Society 56th Annual Meeting*, Boston, MA, pp. 2002-2005.

C. Lowenthal, C.M. Oman, A.M. Liu, A. Natapoff. (2012) "The Effects of Sleepiness on Performance." *Proc of the 26th Annual Meeting of the Associated Professional Sleep Societies (SLEEP 2012)*, Boston, MA, June 9-13.

C. Lowenthal, A.M. Liu, A. Natapoff, and C.M. Oman. (2012) "Effect of Sleepiness on Performance and Workload During Space Robotics Tasks." *Aviation, Space and Environmental Medicine*, 83(3): 274.

A.M. Liu, M. Rueger, L.K. Barger, G.C. Brainard, C.A. Czeisler, E.E. Flynn-Evans, R.E. Forman, C.S. Lowenthal, A. Natapoff, C. Quincy, D. Schulz, P.N. Williamson, C.M. Oman, and S.W. Lockley. (2011) "Validation of Assessment Tests and Countermeasures for Detecting and Mitigating Changes in Cognitive Function During Robotics Operations." *Proc. of the 18th IAA Humans in Space Symposium*, Houston, TX, April 11-15.

C. S. Lowenthal, R. E. Forman, A. M. Liu, A. Natapoff, and C. M. Oman. (2011) "Workload Measurement During Space Robotics Tasks." *Proc. of the 18th IAA Humans in Space Symposium*, Houston, TX, April 11-15.

T.M. Pontillo, A.M. Liu, A. Natapoff, and C.M. Oman. (2011) "Spatial Ability, Joystick Configuration, and Handedness as Predictors of Space Teleoperation Performance." *Proc. of the 18th IAA Humans in Space Symposium*, Houston, TX, April 11-15.

R. E. Forman, C. S. Lowenthal, C. M. Oman, A. M. Liu , and A. Natapoff. (2011) "A Review of Space Robotics Metrics and Proposed Objective Performance Metrics for Improved Telerobotics Training." *Proc. of the 18th IAA Humans in Space Symposium*, Houston, TX, April 11-15.

C.M. Oman, A.M. Liu, A. Natapoff, Z.A. Tomlinson, and T.M. Pontillo. (2010) "Influence of Spatial Abilities and Fatigue Space Telerobotics Operator Performance." *Aviation, Space, and Environmental Medicine*, 81(3): 214.

J.D. Kaderka, J. Mateus, A. Liu, and L.R. Young. (2010) "Partial Gravity Effects on Slope Estimation" *Aviation, Space, and Environmental Medicine*, 81(3): 220.

T.M. Pontillo, C.M. Oman, A.M. Liu, A. Natapoff, and Z.A. Tomlinson. (2010) "Role of Spatial Ability in Camera Selection for Space Teleoperation Tasks." *Aviation, Space, and Environmental Medicine*, 81(3): 255.

C.T. Oravetz, L.R. Young, A.M. Liu, and H. Hecht. (2009) "Slope and Distance Estimation Errors in a Lunar Environment." *Aviation, Space, and Environmental Medicine*, 80(3): 221.

Z.A. Tomlinson, C.M. Oman, A.M. Liu, A. Natapoff, A. Collins, and J.B. Silverman. (2009) "Influence of spatial ability on primary and secondary space telerobotics operator performance." *Aviation, Space, and Environmental Medicine*, 80(3): 221.

K.R. Duda, L.R. Young, C.M. Oman, A.M. Liu, A. J. Stimpson, and T. Clark. (2009). "Evaluation of sensorimotor performance during lunar landing." *Aviation, Space, and Environmental Medicine*, 80(3): 230.

C.M. Oman, A.M. Liu, S. Popkin, J.K. Pollard, H. Howarth, and A. Aboukhalil. (2009) "Locomotive Alerter Technology Assessment." *Proc. of the 2009 International Conference on Fatigue Management in Transportation Operations*, Boston, MA, March 24-26, p. 30.

A. Collins, Z. Tomlinson, C. Oman, A. Liu, and A. Natapoff. (2008) "Investigating Effectos of Frame Disparity on the Performance of Telerobotic Tasks." *Proc. of the 59th International Astronautical Congress*, Glasgow, Scotland, Sept 29 - Oct 3.

A.M. Liu, C.M. Oman, A. Natapoff, and C. Coleman. (2008) "Spatial Ability as a Predictor of Space Robotics Training Performance." *Aviation, Space, and Environmental Medicine*, 79(3): 289.

C.M. Oman, C. Cizaire, A. Natapoff, H. Aoki, D.A. Buckland, and A.M. Liu. (2008) "Effect of Docked Spacecraft Configuration on Spatial Orientation." *Aviation, Space, and Environmental Medicine*, 79(3): 326.

C.T. Oravetz, K. Ingle, L. Young, and A.M. Liu. (2008) "Astronaut Slope and Surface Estimations for Lunar Exploration." *Aviation, Space, and Environmental Medicine*, 79(3): 326-7.

M.A. Menchaca-Brandan, A.M. Liu, C.M. Oman, and A. Natapoff. (2007) "Influence of Perspective-Taking and Mental Rotation Abilities in Space Teleoperation." *Proc. of the 2nd ACM/IEEE Conference on Human-Robot Interaction (HRI07)*, Washington, DC, Mar 9-11.

C.M. Oman, D. Benveniste, D.A. Buckland, H. Aoki, A. Liu, A. Natapoff, and M. Kozhevnikov. (2006) " Spacecraft Module Visual Verticals and Individual Spatial Abilities Determine 3D Spatial Task Performance." *Aviation, Space, and Environmental Medicine*, 77(3): 543.

C.M. Oman, D. Benveniste, D. Buckland, H. Aoki, A. Liu, and A. Natapoff. (2006) "Spacecraft Module Visual Verticals and Training Affect Spatial Task Performance." *Habitation*, 10(3/4):202-203.

A. Liu, K. Duda, C.M. Oman, and A. Natapoff. (2004) "The Perception of Linear Self-Motion During 0-G Parabolic Flight." *Journal of Vestibular Research*, 14(2-3): 114.

J.J. Marquez, C.M. Oman, and A.M. Liu (2004) "You-Are-Here Maps for International Space Station: Approach and Guidelines." *Proc. of the 34th International Conference on Environmental Systems*, Colorado Springs, CO, July 19-22.

A. Liu, K. Duda, C.M. Oman, and A. Natapoff. (2002) "Effects of parabolic flight zero-gravity on looming linear vection." *Journal of Vestibular Research*, 11(3-5): 325.

J.J. Marquez, C.M. Oman, A. Liu, and A. Beall. (2002) "Spacecraft-in-Miniature: a tool for the acquisition of mental representations of large environments." *Journal of Vestibular Research*, 11(3-5): 338-9.

D. Salvucci, A. Liu, and E. Boer. (In press) "The Time Course of Driver Eye Movements During a Lane Change." In A.G. Gale, Ed., *Vision in Vehicles IX*, Oxford: Elsevier.

W. Albert and A. Liu. (In press) "The effects of map orientation and perspective on visual attention while using an in-vehicle navigation system." In A.G. Gale, Ed., *Vision in Vehicles VIII*, Oxford: Elsevier.

A. Liu, C.M. Oman, A.C. Beall, I.P. Howard, T. Smith, L.R. Young, L. Harris, and M. Jenkin. (2001) "Human Orientation in Prolonged Weightlessness (ISS E085)." *Proc. of the AIAA Conference on International Space Station Utilization*. On CD-ROM, Cape Canaveral, FL, October 15-18.

A. Liu and D. Salvucci. (2001) "Modeling and Prediction of Human Driver Behavior." In M.J. Smith, G. Salvendy, D. Harris, R.J. Koubek, Eds., *Usability Evaluation and Interface Design: Cognitive Engineering, Intelligent Agents, and Virtual Reality*. Mahwah, NJ: Lawrence Erlbaum, pp. 1479-1483.

N. Kuge, T. Yamamura, O. Shimoyama, and A. Liu. (2000) "A Driver Behavior Recognition Method Based on a Drive Model Framework." *Proc. of the SAE World Congress*, Detroit, MI, March 6-9.

A. Liu. (1999) "Towards Predicting Driver Intentions from Patterns of Eye Movements." In A.G. Gale, Ed., *Vision in Vehicles VII*, Oxford: Elsevier, pp. 205-212.

M. Fernández, A. Liu, M. Lozano, and G. Martin. (1999) "Stochastic Approach to the Evaluation and Classification of Driver Behavior in Driving Simulators." *Proc. of the 10th Intl. Training and Education Conference*, The Hague, Netherlands, April 13-15.

A. Liu, L. Veltri, and A. P. Pentland. (1998) "Modelling Changes in Eye Fixation Patterns While Driving." In A.G. Gale, Ed., *Vision in Vehicles VI*, Amsterdam: Elsevier, pp. 13-20.

A. Liu and A.P. Pentland. (1997) "Towards Real-Time Recognition of Driver Intention." *Proc. of the 1997 IEEE Intelligent Transportation Systems Conference*, pp. 236-241, Boston, MA, November 9-12.

E. Boer, M. Fernández, A. Pentland, and A. Liu (1996) "Method for evaluating human and simulated drivers in real traffic situations." *Proc. of the 1996 IEEE Vehicular Technology Conference*, pp. 1810-1814, Atlanta, GA.

M. Fernández, A. Liu, S. Bayarri, and A. P. Pentland. (1996) "Tuning of Driver Behavior Models Used in Driving Simulators." *Proc. of the 1996 Intl. Conf. on Traffic and Transport Psychology*, pp. 191-196, Valencia, Spain, May 22-25.

A. Liu and S. Chang. (1995) "Force Feedback in a Stationary Driving Simulator." *Proc. of the 1995 IEEE Intl. Conf. on Systems, Man, and Cybernetics*, vol. 2, pp. 1711-1716, Vancouver, BC, Canada, October 23-25.

A. P. Pentland and A. Liu. (1995) "Towards Augments Control Systems." *Proc. of the 1995 IEEE Intelligent Vehicles Symposium*, pp. 350-355, Detroit, MI, September 23-25.

A. Liu, G. Tharp, and L. Stark. (1992) "Effect of Stereo and Occlusion on Simulated Telemanipulation." *Proc. 1992 SID International Symposium*, pp. 833-6, Boston, MA, May 17-22.

A. Liu, G. Tharp, and L. Stark. (1992) "Depth Cue Interaction in Telepresence and Simulated Telemanipulation". In Bernice E. Rogowitz, Ed., *Human Vision, Visual Processing and Digital Display III*, SPIE 1666, pp. 541-7.

G. Tharp, A. Liu, and L. Stark. (1992) "Timing Considerations of Helmet-mounted Display Performance." In Bernice E. Rogowitz, Ed., *Human Vision, Visual Processing and Digital Display III*, SPIE 1666, pp. 541-7.

A. Liu, L. Stark, and M. Hirose. (1991) "Interaction if Visual Depth Cues and Viewing Parameters During Simulated Telemanipulation." *Proc. of the 1991 IEEE Intl. Conf. on Robotics and Automation*, pp.2286-91, Sacramento, CA, April 7-12.

B. Baker, A. Liu and S. Baumrind. (1990) "Graphic Display of Craniofacial X-Ray Data Overlaid in Digital Images." *Proc. of the IEEE Intl. Conf. on Engineering in Medicine and Biology*, p. 334, Philadelphia, PA, November.

B. Baker, S. Baumrind, A. Liu, and S. Curry (1990) "Reliability of Cephalometric Landmark Location Directly on a Computer Monitor." *Proc. of the IEEE Intl. Conf. on Engineering in Medicine and Biology*, p. 333, Philadelphia, PA, November.

L. Stark, S. Ellis, M. Hirose, W. S. Kim, A. Liu, C. Neveu, A. H. Nguyen, G. Tharp, and I. Yamashita. (1990) "Making a Picture Fit the Eye: Human Engineering for Computer Graphics." *Proc. of the IEEE Visualization '90 (Panel Session)*, pp. 411-420, San Francisco, CA, October 23-26.

M. Hirose, T. Myoi, A. Liu, and L. Stark. (1990) "Object Manipulation in the Virtual Environment: Case of the Fixed Display." *Proc. of the Human Interface Symposium*, pp. 571-576, Tokyo, Japan, October 24-26.

G. Tharp, A. Liu, H. Yamashita, L. Stark, B. Wong, and J. Dee. (1988) "A Helmet Mounted Display to Adapt the Telerobotic Environment to Human Vision." *Proc. of the 3rd Annual Workshop on Space Operations, Automation, and Robotics*, pp. 477-81, Houston, TX, July 25-29.

W. S. Kim, A. Liu, K. Matsunaga, and L. Stark. (1988) "A Helmet Mounted Display for Telerobotics." *Proc. of IEEE Computer Society COMPCON*, pp. 543-7, San Francisco, CA.

Publications (Other)

FRA Research Report (Aug 2017) "A Preliminary Design for a Head-Up Display for Rail Operations." RR-17-08.

A.M. Liu, R. Galvan-Garza, Y.K. Yang, and C.M. Oman (2017) "Design and Automation of Electronic Checklists for Robotic Operations" 2017 NASA Human Research Program Investigators' Workshop, Galveston, TX, Jan 23-26 (abstract)

A.M. Liu, E. Flynn-Evans, R.C. Galvan, M. Rueger, A. Natapoff, C.M. Oman, and S.W. Lockley (2016) "Validation of assessment tests and countermeasures for detecting and mitigating changes in cognitive function during telerobotic operations" 2016 NASA Human Research Program Investigators' Workshop, Galveston, TX, Feb 8-11 (abstract)

N. Subrahmaniyan, B. Miller, A. Liu, H. Groshong, and J. Brooks (2015) "Modeling Human-Automation Function Allocation Effectiveness in Rail." IIE Annual Conference & Expo, ISERC 2015, Nashville, TN, May 30-Jun 2.

A.M. Liu, R.C. Galvan, M. Rueger, E.E. Flynn-Evans, A. Natapoff, S.W. Lockley, and C.M. Oman (2015) "Validation of assessment tests and countermeasures for detecting and mitigating changes in cognitive function due to fatigue during telerobotic operations" 2015 NASA Human Research Program Investigators' Workshop, Houston, TX, Feb. (abstract)

A.M. Liu, R.C. Galvan, M. Rueger, E.E. Flynn-Evans, A. Natapoff, S.W. Lockley, and C.M. Oman (2013) "Validation of assessment tests and countermeasures for detecting and mitigating changes in cognitive function due to fatigue during telerobotic operations" 2013 NASA Human Research Program Investigators' Workshop, Houston, TX, Feb 12-14 (abstract)

A.M. Liu, V. Wang, R.E. Forman, R.C. Galvan, A. Natapoff, and C.M. Oman (2012) "Advanced Displays for Efficient Training and Operation of Robotic Systems." 2012 NASA Human Research Program Investigators' Workshop, Houston, TX, Feb 14-16 (abstract)

A.M. Liu, C.S. Lowenthal, R.C. Galvan, R.E. Forman, M. Rueger, E.E. Flynn-Evans, A. Natapoff, S.W. Lockley, and C.M. Oman (2012) "Assessment and countermeasures for detecting and mitigating changes in cognitive function during robotics operations." 2012 NASA Human Research Program Investigators' Workshop, Houston, TX, Feb 14-16 (abstract)

L.R. Young, A.M. Liu, and C. Oravetz. (2008) "Lunar Slope and Distance Estimation." Proc. of the ESA Life in Space for Life on Earth Conference, Angers, France, June.

C. Cizaire, C.M. Oman, D. Buckland, A. Natapoff, H. Aoki, and A.M. Liu. (2007) "Effect of two-module docked spacecraft configurations on spatial orientation." Proc. of the 16th IAA Humans in Space Symposium, Beijing, China, May 20-24.

H. Aoki, C.M. Oman, A. Natapoff, and A. Liu. (2006) "The effect of the configuration, frame of reference, and spatial ability on spatial orientation during virtual 3-dimentional navigation training." Proc. of the ESTEC Seventh Symposium on the Role of Vestibular Organs in Space Exploration Nordwijk, The Netherlands, June 7-9.

C.M. Oman, D. Benveniste, D. Buckland, H. Aoki, A. Liu, A. Natapoff, and M. Kozevnikov. (2006) "Incongruent Spacecraft Module Visual Verticals Affect Spatial Task Performance." Proc. of the ESTEC Seventh Symposium on the Role of Vestibular Organs in Space Exploration Nordwijk, The Netherlands, June 7-9.

C.M. Oman and A. Liu (2005) "Mars Mission Concept Explotation and Refinement Study Phase 2 Final Report: Human Factors Engineering." CS Draper Laboratory, 555 Technology Square, Cambridge, MA 02139, pp. 1-38.

C.M. Oman, L. Harris, J. Taube, R. Dyde, H. Jenkin, A. Liu, D. Benveniste, D.A. Buckland, A. Natapoff, and J. Richards. (2005) "Visual orientation, navigation and spatial memory: mechanisms and countermeasures." USRA Bioastronautics Investigators' Workshop, Galveston, TX, Jan.

C.M. Oman, L. Harris, W. Shebilske, J. Taube, A. Liu, and J. Richards. (2003) "Visual Orientation and Spatial Memory: Mechanisms and Countermeasures." USRA Bioastronautics Investgators' Workshop, Galveston, TX, Jan 13-15.

A.M. Liu, C.M. Oman, A. Berthoz, J.A. McIntyre, F. Lacquaniti, A.C. Beall, T. Smith, L.R. Young, L. Harris, M. Jenkin, and M. Zago. (2003) "Human Orientation and Sensory-Motor Coordination in Microgravity." Bioastronautics Investigators' Workshop, Galveston, TX, Jan 13-15.

C.M. Oman, A.M. Liu, J.J. Marquez, W.B. Sachtler, W.E. Hutchison, A.C. Beall, and A. Natapoff. (2001) "Advanced Displays and Controls for six degree of freedom orientation and navigation in virtual microgravity. Bioastronautics Investigators' Workshop, Jan 17-19, Galveston, TX.

A. Liu (1998) "1998 CBR Workshop on Human Interaction with Automated Systems." CBR Technical Report TR98-1, Cambridge Basic Research, Cambridge, MA.

E. Boer and A. Liu. (1997) "Cambridge Basic Research 1997 Annual Report." CBR Technical Report TR97-7, Cambridge Basic Research, Cambridge, MA.

I. Subbiah, L. Veltri, A. Liu, and A. Pentland. (1996) "Paths, Landmarks, and Edges as Reference Frames in Mental Maps of Simulated Environments." CBR Technical Report TR96-11, Cambridge Basic Research, Cambridge, MA.

E. Boer, W. Richards, A. Liu, and M. Figueroa. (1996) "Techniques for measuring steady-state driving performance." CBR Technical Report TR96-10, Cambridge Basic Research, Cambridge, MA.

E. Boer, M. Fernández, A. Pentland, and A. Liu. (1996) "Method for evaluating human and simulated drivers." CBR Technical Report TR96-3, Cambridge Basic Research, Cambridge, MA.

A. P. Pentland and A. Liu. (1996) "Observing Drivers' Intention." CBR Technical Report TR96-2, Cambridge Basic Research, Cambridge, MA.

A. Liu and J. Beusmans, Eds. (1994) "Cambridge Basic Research 1994 Annual Report." CBR TR94-2, Cambridge Basic Research, Cambridge, MA.