

## **ROBERT V. KENYON**

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### **Professional Experience**

- 2019-Present University of Illinois at Chicago, Department of Computer Science; Professor Emeritus.
- 2009-2019 University of Illinois at Chicago, Department of Computer Science; Director of Graduate Studies.
- 2007-2019 University of Illinois at Chicago, Department of Computer Science; Professor.
- 2007-2019 University of Illinois at Chicago, Department of Bioengineering; Adjunct Professor.
- 2007-2019 Northwestern Medical School, Northwestern University, Department of Physical Medicine and Rehabilitation, Adjunct Professor.
- 2015 Massachusetts Institute of Technology, Department of Aeronautics and Astronautics; Visiting Professor. [January-July]
- 2001-2007 University of Illinois at Chicago, Department of Computer Science; Associate Professor.
- 2004-2007 University of Illinois at Chicago, Department of Bioengineering; Adjunct Associate Professor.
- 2004-2007 Northwestern Medical School, Northwestern University, Department of Physical Medicine and Rehabilitation, Adjunct Associate Professor.
- 2006 College de France, Laboratoire de Physiologie de la Perception et de l'Action, and Centre National de la Recherche Scientifique, Visiting Associate Professor, January - August.
- 2000-2003 University of Washington, Department of Industrial Engineering, Human Interface Technology Laboratory, Visiting Associate Professor.
- 1996 Summer Research Associate at Wright-Patterson AFB, OH.
- 1996 Summer Research Associate at Wright-State Univ., Dayton, OH.
- 1986-2001 University of Illinois at Chicago, Department of Electrical Engineering and Computer Science; Associate Professor.
- 1985-1986 Massachusetts Institute of Technology, Department of Aeronautics and Astronautics; Associate Professor.
- 1979-1986 Joint appointment: Whitaker Health Sciences and Technology, Harvard Medical School-MIT Joint Programs.
- 1979-1985 Massachusetts Institute of Technology, Department of Aeronautics and Astronautics; Assistant Professor.

### **Consulting**

- 1979 University of Dayton: Consultant on Eye Movement technology applied to Flight Simulation.
- 1980-1983 State University of New York: Consultant on real-time computers applied to human experimentation.

- 1982 Ad Hoc Advisor on Airlift, USAF Military Airlift Command: Visual factors associated with air refueling.
- 1982-1984 HH Aerospace Design: Consultant on Flight Simulator Imaging technology.
- 1985-1987 Environmental Tectonics Corp.: Consultant on performance measures of Pilots in high-g centrifuge environment.
- 1985-1987 Applied Sciences Laboratory: Consultant on Flight Simulator Display Technology.
- 1985-1988 Director/Instructor of M.I.T. Summer course on: Fundamentals of Flight Simulation (for Industry/Government Professionals). Course taught with two other faculty.
- 1990 USAF School of Aerospace Medicine: Workshop on manual control methods and visual research; real-time data acquisition systems.
- 1990 Advanced Data Systems: Consultant for NFS report on thirty year projection of US computer needs and uses in science and industry.
- 1990-Present Legal Consultant on: Engineering, Computers, and Graphics.
- 1996 USAF Armstrong Aerospace Med. Res. Lab, Wright-Patterson, AFB, OH
- 1999-Present General Motors Research and Development Center, Warren, Mi: Perception in Surround-Screen Stereoscopic Display Systems
- 2000-2003 Eastman Kodak Co., Human Factors in Virtual Environments.  
*Wright State University, Department of ECS, Dayton, OH.*

#### **Awards and Fellowships**

- 1971-1972 Presbyterian St. Luke's Hospital, Chicago & University of Illinois Chicago Circle; Research Assistant.
- S: 1973 Smith Kettlewell Institute of Visual Science; Research Assistant.
- 1973-1979 Pre-doctoral Trainee, National Institutes of Health.
- 1978-1979 Post Doctoral Fellowship, National Institutes of Health.
- 1975-1979 Assistant Director of Neuro-optometry Clinic, School of Optometry, Berkeley.
- 1978-1979 University of California, San Francisco; Neuro-Ophthalmology Unit, Research Assistant.
- S: 1979 Fellow, Faculty Research Program, U.S. Air Force Office of Scientific Research.
- S: 1979 Southeastern Center for Electrical Engineering Education; Summer Faculty Research Fellow.
- 2001 *External Team Member: Innovation Achievement Award, Eastman Kodak Co.*
- 2017 Charles E. Ives Journal Award, Society for Imaging Science and Technology.

#### **Education**

University of California, Berkeley	1973-1978	Ph.D.	Physiological Optics
University of Illinois, Chicago	1971-1972	M.S.	Bioengineering
University of Rhode Island, Kingston	1966-1971	B.S.	Electrical Engineering

## PUBLICATIONS

### Peer Reviewed Journals

1. Ciuffreda, K.J., Bahill, A.T., Kenyon, R.V., and Stark, L.: [Eye movements during reading: Case Reports](#). Amer. Journal of Optometry and Physiological Optics **53**: 389-395, 1976.
2. Bahill, A.T., Ciuffreda, K.J., Kenyon, R.V., and Stark, L.: [Dynamic and static violations of Hering's Law of Equal Innervation](#). Amer. Journal of Optometry and Physiological Optics **53**: 798-808, 1976.
3. Stark, L., Bahill, A.T., Ciuffreda, K.J., Kenyon, R.V., and Phillips, S.: [Neuro-Optometry: An evolving specialty clinic](#). Amer. Journal of Optometry and Physiological Optics **54**: 85-96, 1977.
4. Kenyon, R.V., Ciuffreda, K.J., and Stark, L.: [Binocular eye movements during accommodative vergence](#). Vision Research **18**: 545-555, 1978.
5. Ciuffreda, K.J., Kenyon, R.V., and Stark, L.: [Increased saccadic latencies in amblyopic eyes](#). Inves. Ophth. & Vis. Sci. **17**: 697-702, 1978.
6. Ciuffreda, K.J., Kenyon, R.V., and Stark, L.: [Processing delays in amblyopic eyes: Evidence from increased latencies](#). Amer. J. Opt. & Physiol. Optics **55**: 187-196, 1978.
7. Ciuffreda, K.J., Kenyon, R.V., and Stark, L.: [Different rates of functional recovery of eye movements during orthoptics treatment in an adult amblyope](#). Invest. Ophth. & Vis. Sci. **18**: 213-219, 1979.
8. Ciuffreda, K.J., Kenyon, R.V., and Stark, L.: [Abnormal saccadic substitution during constant velocity tracking in amblyopic eyes](#). Invest. Ophth. & Vis. Sci. **18**: 506-516, 1979.
9. Ciuffreda, K.J., Kenyon, R.V., and Stark, L.: [Saccadic intrusions in strabismus](#). Arch. Ophth. **97**: 1673-1677, 1979.
10. Ciuffreda, K.J., Kenyon, R.V., and Stark, L.: [Suppression of fixational saccades in strabismic and anisometropic amblyopia](#). Ophthalmic. Res. **11**: 31-39, 1979.
11. Ciuffreda, K.J., Kenyon, R.V., and Stark, L.: [Increased drift in amblyopic eyes](#). Brit. J. Ophth. **64**: 7-14, 1980.
12. Ciuffreda, K.J., Kenyon, R.V., and Stark, L.: [Fixational eye movements in amblyopia and strabismus](#). Am. Ophth. Assoc. J. **50**: 1251-1258, 1979.
13. Kenyon, R.V., Ciuffreda, K.J., and Stark, L.: [Dynamic vergence eye movements in strabismus and amblyopia: Symmetric vergence](#). Invest. Ophth. & Vis. Sci. **18**: 60-74, 1980.

14. Kenyon, R.V., Ciuffreda, K.J., and Stark, L.: [An unexpected role for accommodative vergence in strabismus and amblyopia](#). Am. J. Ophth. and Physiol. Optics. **57**: 566-577, 1980.
15. Kenyon, R.V., Ciuffreda, K.J., and Stark, L.: [Unequal saccades during vergence](#). Am. J. Ophth. & Physiol. Optics. **57**: 586-594, 1980.
16. Stark, L., Kenyon, R.V., Krishnan, V.V., and Ciuffreda, K.J.: [Disparity Vergence: A proposed name for a dominant component of binocular vergence eye movements](#). Am. J. Ophth. & Physiol. Optics. **57**: 606-609, 1980.
17. Kenyon, R.V., Ciuffreda, K.J., and Stark, L.: [Asymmetric and accommodative vergence eye movements in strabismus and amblyopia](#). Brit. J. Ophthal. **66**: 167-176, 1981.
18. Ciuffreda, K.J., Kenyon, R.V., and Stark, L.: [Saccadic intrusions contributing to reading disability: A Case Report](#). Am. J. Ophthal. and Physiol. **60**: 242-249, 1983.
19. Kenyon, R.V., and Stark, L.: [Unequal saccades generated by velocity interactions in the peripheral oculomotor system](#). Mathematical Biosciences, **63**: 187-198, 1983.
20. Parker, A.J., Kenyon, R.V. and Troxel, D.: [Comparison of interpolating methods for image resampling](#). IEEE Trans. Med. Imaging, MF-2: 31-39, 1983.
21. Stark, L., Ciuffreda, K.J., Grisham, J.D., Kenyon, R.V., Liu, J., Polse, K.: [Accommodative disfacility presenting as intermittent exotropia](#). Ophthalmic. & Physiol. Optics, **4**: 233-244, 1984.
22. Kenyon, R.V., Becker, J.T., Butters, N. and Hermann H.: [Oculomotor function in Wernicke-Korsakoff's syndrome: saccadic eye movements](#), Intern. J. NeuroSciences **25**: 67-79, 1984.
23. Kenyon, R.V., Becker, J.T., and Butters, N.: [Oculomotor function in Wernicke-Korsakoff's Syndrome: Smooth pursuit eye movements](#), Intern. J. NeuroSciences **25**: 53-65, 1984.
24. Parker, A.J., Kenyon, R.V. and Young, L.R.: [Measurement of torsion from multi-temporal images of the eye using digital signal processing techniques](#), IEEE Trans. Biomed. Eng. **BME-32**: 28-36, 1985.
25. Kenyon, R.V. [A soft contact lens search coil for measuring eye movements](#). Vision Research **25**: 1629-1633, 1985.
26. Kenyon, R.V. and Young, L.R.: [MIT Canadian vestibular experiments on Spacelab-1 mission: 5. Postural responses following exposure to weightlessness](#). Exp. Brain Res. **64**: 335-346, 1986.
27. Young, LR, Oman, CM, Watt, DGD, Money, KE, Lichtenberg, BK, Kenyon RV, and Arrott, AR. [MIT Canadian vestibular experiments on Spacelab-1 mission: 1. Sensory](#)

- [adaptation to weightlessness and readaptation to one-g: an overview](#). Exp. Brain Res. **64**: 291-298, 1986.
28. Kenyon, R.V. Kerschmann R. and Silbergleit R: [Streptomycin in the chick embryo: Post-hatching vestibular behavior and morphology](#). Exp. Brain Res. **69**: 260-271, 1988.
  29. Cruz-Neira C, Sandin D, Defanti T, Kenyon R, and Hart J., [The CAVE Audio-Visual Environment](#). ACM Trans. on Graphics, **35**: 65-72, 1992.
  30. Kenyon R. and Kneller, E., [The Effects of Field-of-View Size on the Control of Roll Motion](#). IEEE Trans. Systems, Man and Cybern., **23**:183-193, 1993.
  31. Previc, F., Kenyon R., Boer, E., and Johnson, B., [The Effects of Visual Roll Stimulation on Postural and Manual Control and Self-Motion Perception](#). Perception and Psychophysics, **54**: 93-107, 1993.
  32. Kenyon R., Kerschman, R., Sgarioto, R., Jun S., and Vellinger J. [Normal Vestibular Development in the Chicks after Exposure to Microgravity during Development](#). J. Vestibular Research, **5**: 289-298, 1995.
  33. Kenyon RV, DeFanti TA, Sandin DJ. [Visual Requirements for Virtual Environment Generation](#). Journal of the Society for Information Display, 3 (4), 211-214, 1995.
  34. Kenyon R and Afenya M, [Training in Virtual and Real Environments](#), Annals of Biomedical Engineering, **23**: 445-455, 1995.
  35. Boer, E. R. and Kenyon R. V., [Estimation of Time Varying Delay Time in Non-Stationary Linear Systems: An Approach to Monitor Human Operator Adaptation in Manual Tracking Tasks](#), IEEE Trans. Man, Systems and Cybern., 28(1): 89-99, 1998.
  36. Shapiro, MB and Kenyon, RV. [Control variables in mechanical muscle models: A mini-review and a new model](#). Motor Control, 4, 329-349, 2000.
  37. Keshner E.A. and Kenyon R.V. [The influence of an immersive virtual environment on the segmental organization of postural stabilizing responses](#). Journal of Vestibular Research, 10:207-219, 2000.
  38. Duh, H.B.L., Lin, J.J.W., Kenyon, R.V., Parker, D.E., Furness, T.A, [Effects of Characteristics of Image Quality in an Immersive Environment](#). Presence, Vol. 11, No. 3, 2002.
  39. Keshner E.A., Kenyon R.V., and Langston, J. [Postural Responses Exhibit Intra-Modal Dependencies with Discordant Visual and Support Surface Motion](#), Journal of Vestibular Research 14, 307-319, 2004.
  40. Kenyon, R.V., Leigh, J, and Keshner, E.A. [Considerations for the Future Development of Virtual Technology as a Rehabilitation Tool](#). Journal of NeuroEngineering and Rehabilitation, (1) 1: 13, 2004.

41. Keshner E.A. and Kenyon R.V. [Using immersive technology for postural research and rehabilitation](#). J. Assistive Technology, 16:1, 54-62, 2004.
42. Patton, J., Dawe, G., Scharver, C., Mussa-Ivaldi, F., Kenyon, R.V. [Robotics and Virtual Reality: A Perfect Marriage for Motor Control Research and Rehabilitation](#), J. Assistive Technology, 18 (2), 2006.
43. Keshner, EA, Dokka, K. and Kenyon, RV. [Influences of the Perception of Self-Motion on Postural Parameters in a Dynamic Visual Environment](#). Cyber Psychology and Behavior, 9 (2), 163-166, 2006.
44. Dvorkin, AY., Kenyon, RV, and Keshner, EA. [Reaching Within a Dynamic Virtual Environment](#). *Journal of NeuroEngineering and Rehabilitation* 2007, 4:23, 2007.
45. Fischer HC, Stubblefield K, Kline TL, Luo X, Kenyon RV, Kamper DG. [Hand Rehabilitation Following Stroke: A Pilot Study of Assisted Finger Extension Training in a Virtual Environment](#). Topics in Stroke Rehab 2007; 14: 1-12.
46. Kenyon, R.V., Sandin, D. Smith, R., Pawlicki, R. and Defanti, T. [Size-Constancy in the CAVE](#), Presence: Teleoperators & Virtual Environments, Vol. 16, No. 2, pp. 172-187, 2007.
47. Streepey, J, Kenyon, RV, and Keshner, EA. [Field of view and base of support width influence postural responses to visual stimuli during quiet stance](#). Gait and Posture, Vol. 25, Issue 1, pp. 49-55, 2007.
48. Streepey, J, Kenyon, RV, and Keshner, E.A. [Visual motion combined with base of support width reveals variable field dependency in healthy young adults](#). Exp. Brain Res, Vol. 176, No. 1, pp. 182-187, 2007.
49. Gauthier, Gabriel; Hansmann, Doug; Kenyon, Bob; Semmlow, John; Usui, Shiro and Young, Larry. Editorial: [The arts and sciences of Lawrence Stark](#). Computers in Biology and Medicine, Vol. 37, Issue 7, 898-902, 2007.
50. Dvorkin, A., Kenyon, R.V., and Keshner, E.A. [Reaching within a dynamic virtual environment](#). Journal NeuroEngineering and Rehabilitation, 4(23), 2007.
51. Kenyon, R.V., Phenany, M., Sandin, D. and Defanti, T. [Accommodation and Size-Constancy of Virtual Objects](#). Annals of Biomedical Engineering, Vol 36, No 2 , pp. 342-348, 2008.
52. Dvorkin, Assaf ; Kenyon, Robert; Keshner, Emily. [Effects of roll visual motion on online control of arm movement: reaching within a dynamic virtual environment](#). Experimental Brain Research. 193(1):95-107, 2009.
53. Dokka, K, Kenyon, R. and Keshner, K. [Influence of visual scene velocity on segmental kinematics during stance](#). Gait and Posture, Gait and Posture, 30(2): 211-216, 2009.

54. Dokka K, Kenyon RV, Keshner EA, Kording KP. [Self versus Environment Motion in Postural Control](#). PLoS Comput Biol 6(2): e1000680, 2010.
55. Wang Y, Kenyon RV, Keshner EA. [Identifying the control of physically and perceptually evoked sway responses with coincident visual scene velocities and tilt of the base of support](#). Exp Brain Res. 201(4):663-72, 2010.
56. Connelly L, Jia Y, Toro ML, Stoykov ME, Kenyon RV, Kamper DG. [A pneumatic glove and immersive virtual reality environment for hand rehabilitative training after stroke](#). IEEE Trans Neural Syst Rehabil Eng. 18(5):551-9. 2010.
57. Gurses, S, Kenyon, R. and Keshner, K. [Examination of time-varying kinematic responses to support surface disturbances](#). Biomedical Signal Processing and Control. 6(1), pp: 85-93, 2011.
58. Abdollahi, F., Case, E., Listenberger, M., Kenyon, R., Kovic, M., Bogey, R., Hedeker, D., Jovanovic, B., Patton, J. “[Error augmentation enhancing arm recovery in individuals with chronic hemiparetic stroke: a randomized crossover design](#).” Journal of Neurorehabilitation and Neural Repair, 2013.
59. Abdollahi, F., Kenyon, R., Patton, J. “[Mirror versus parallel bimanual reaching](#)” Journal of NeuroEngineering and Rehabilitation, 10:71, 2013.
60. Mosnaim, G., Li, H., Martin, M., Richardson, D., Belice, P., Avery, E., Silberstein, A., Leigh, J., Kenyon, R., Jones, S., Bender, B., Powell, L. A Tailored Mobile Health Intervention to Improve Adherence and Asthma Control in Minority Adolescents, Journal of Allergy and Clinical Immunology: In Practice, Volume 3, Issue 2, March–April 2015, Pages 288-290.e1, ISSN 2213-2198, <http://dx.doi.org/10.1016/j.jaip.2014.10.011>.
61. Tyler Johnson, Nikhil Nandakumar, Robert Kenyon and James Patton, Sensory Recalibration from Visually Amplified Rotations While Walking. Critical Reviews in Biomedical Engineering, 2015, 43(4), 245-253.
62. Chihua Ma, Angus Forbes, Daniel Llano, Tanya Berger-Wolf, and Robert Kenyon. SwordPlots: exploring neuron behavior within dynamic communities of brain networks (JIST-first), J. Imaging Sci. Technol., Vol 60, No 1, January 2016, pp. 10405-1-10405-13(13).
63. Grossman B, Conner S, Mosnaim G, Albers J, Leigh J, Jones S, Kenyon R, Application of Human Augmentics: A Persuasive Asthma Inhaler, J Biomed Inform 67: 51-58. Available online, 2017, ISSN 1532-0464, <http://dx.doi.org/10.1016/j.jbi.2017.02.003>.
64. Ma, Chihua; Pellolio, Filippo; Llano, Daniel A.; Stebbings, Kevin Ambrose; Kenyon, Robert V.; Elisabeta Marai, G. RemBrain: Exploring Dynamic Biospatial Networks with Mosaic-Matrices and Mirror Glyphs. Journal of Imaging Science and Technology, Volume 61, Number 6, November 2017, pp. 60404-1-60404-13(13) [On the Cover of Journal]
65. Farnaz Abdollahia, Molly Corrigan, Emily D.C. Lazzaro, Robert V. Kenyon,

James L. Patton. Error-augmented bimanual therapy for stroke survivors. *NeuroRehabilitation* 43 (2018) 51–61. DOI:10.3233/NRE-182413

66. JW Brown, A Taheri, RV Kenyon, T Berger-Wolf, DA Llano (2019) A computational model of intrathalamic signaling via open-loop thalamo-reticular-thalamic architectures *BioRxiv*, 574178
67. JW Brown, A Taheri, RV Kenyon, T Berger-Wolf, DA Llano (2019) Propagation of cortical activity via open-loop intrathalamic architectures: a computational analysis. *bioRxiv*, 574178
68. BA Ibrahim, C Murphy, G Muscioni, A Taheri, G Yudintsev, RV Kenyon, Tanya Berger-Wolf, Matthew I Banks, Daniel A Llano. (2019) Corticothalamic gating of population auditory thalamocortical transmission in mouse, *bioRxiv*, 625988
69. JW Brown, A Taheri, RV Kenyon, TY Berger-Wolf, DA Llano (2020) Signal propagation via open-loop intrathalamic architectures: a computational model. *Eneuro*, 7 (1).
70. Llano DA , Ma C, Di Fabrizio U, Taheri A, Stebbings KA, Yudintsev G, Xiao G, Kenyon RV, Berger-Wolf TY (2021) A novel dynamic network imaging analysis method reveals aging-related fragmentation of cortical networks in mouse. *Network Neuroscience*, Jun 21;5(2):569-590. [pdf]
71. Naik, A., Kenyon, R.V., Taheril, A., BergerWolf, T.Y., Ibrahim, B.A., Shinagawa, Y., Llano, D.A., V-NeuroStack: Open-source 3D time stack software for identifying patterns in neuronal data, *Journal of Nueroscience Research*, October 12th, 2022. <https://doi.org/10.1002/jnr.25139>

#### Peer Reviewed Conference Papers

1. Stark, L, Shults, T., Ciuffreda, K.J., Hoyt, W.F., Kenyon, R.V., and Ochs, A.: Voluntary nystagmus is saccadic: Evidence for motor and sensory mechanisms. *Proc. of the Joint Automatic Control Conference*, v. 2, June, 1977, pp: 1410-1414.
2. Kenyon, R.V., and Stark, L.: [Unequal saccades produced by non-linear plant dynamics](#). *IEEE Inter. Conf. on Cybern. & Soc.* pp: 596-599, October 8-10, 1980.
3. Kenyon, RV., and Lichtenberg, BK.: [Measurement of ocularcounterrolling \(OCR\) by polarized light](#). *Proceedings of SPIE: Polarizers and Applications*, 307, pp: 79-82, 1981.
4. Kenyon RV, and Kneller, EW. [Human performance and field-of-view](#). *Soc. for Inform. Display Intern. Sympos.*, **23**, pp:290-293, 1992.
5. Boer ER and Kenyon RV, [Identification of Time Varying Systems](#), *IEEE Inter. Conf. on Biomedical Engineering*, Oct 29- Nov 1 pp: 1481-1482, Paris, 1992.
6. Ghazisaedy M, Adamczyk D, Sandin D, Kenyon R, and Defanti T, [UltraSonic Calibration of a Magnetic Tracker in a Virtual Reality Space](#). *Proceedings of the IEEE Annual*



Virtual Reality International Symposium (VRAIS) (Raleigh, NC, March 11-15), pp: 179-188, 1995.

7. Reynolds, W.D. and Kenyon, R.V., [The Wavelet Transform and the Suppression Theory of Binocular Vision for Stereo Image Compression](#). 3rd IEEE International Conference on Image Processing, Lausanne, Switzerland, Sep. 16-19, pp: 557-560, 1996.
8. Isabelle, SK, Gilkey, RH, Kenyon, RV, Valentino, G, Flach J, Spenny, C., Anderson TR., [Defense applications of the CAVE \(CAVE automatic virtual environment\)](#). Proceedings of SPIE: 11th Annual Conference on Aerospace/sensing simulation and control. Cockpit Displays IV: Flat Panel Displays for Defense Applications, Ed: D, Hopper, SPIE Vol. 3057, pp: 118-125, Orlando, Fl, April 20-25, 1997.
9. Boer, E.R.; Kenyon, R.V. [Adaptation asymmetry in manual tracking](#). IEEE Intern. Conf. Systems, Man, and Cybernetics 'Computational Cybernetics and Simulation', Oct 12-15. pp: 3630-3635, vol.4 Orlando, FL, 1997.
10. Leigh, J, Park, K, Kenyon, RV, Johnson, AE, DeFanti, TA. Wong, H. [Preliminary STARTAP Tele-Immersion Experiments between Chicago and Singapore](#), 3rd High Performance Computing Asia Conference & Exhibition, 22-25, pp. 687-693, September, 1998, Singapore.
11. Mascarenhas, R., Karumuri, D., Buy, U., and Kenyon, R. [Modeling and analysis of a virtual reality system with time Petri nets](#). Proceedings of the 20th International Conference on Software Engineering, pp: 33-42, Kokyo, Japan, April 20-22, 1998.
12. Park, K and Kenyon, RV. [Effects of Network Characteristics on Human Performance in the Collaborative Virtual Environment](#). IEEE Virtual Reality '99 Conference, Ed: L. Rosenblum, P. Astheimer, D. Teichmann, pp: 104-111, March 14-17, 1999, Houston Tx, 1999.
13. J Leigh , A Johnson, T DeFanti, M Brown, M Ali, S Bailey, A Banerjee, P Banerjee, J Chen, K Curry, J Curtis, F Dech, B Dodds, I Foster, S Fraser, K Ganeshan, D. Glen, R. Grossman, R. Heiland, J Hicks, A. Hudson, T Imai, M Khan, A Kapoor, R Kenyon, J Kelso, R Kriz, C Lascara, X Liu, Y Lin, T Mason, A Millman, K Nobuyuki, K Park, B Parod, P. Rajlich, M Rasmussen., M Rawlings, D. Robertson, S Thongrong, R. Stein, K Swartz, S Tuecke, H Wallach, H Wong, G. Wheless, [A Review of Tele-Immersive Applications in the CAVE Research Network](#). IEEE Virtual Reality '99 Conference, Ed: L. Rosenblum, P. Astheimer, D. Teichmann, pp: 180-187, March 14-17, 1999, Houston Tx.
14. Duh, H.B.L., Lin, J.J.W., Kenyon, R.V., Parker, D.E., Furness, T.A., (2001), [Effects of field of view on balance in an immersive environment](#), Proceedings of IEEE Virtual Reality 2001 (IEEE VR 2001), Yokohama, Japan, pp 235-240, 2001.
15. Keshner, E.A. and Kenyon R.V. (2002) The development of an immersive laboratory for postural research and rehabilitation. Proceedings of the First International Workshop on Virtual Reality in Mental Health and Rehabilitation, EPFL, Lausanne Switzerland, November, 2002.

16. Keshner, EA and Kenyon RV. [Postural control shifts with sensory discordance](#). International Society for Posture and Gait Research. March 23 - 27, Sydney, Australia. 2003
17. Patton, J. L., G. Dawe, Scharver, C., Muss-Ivaldi, F. A., Kenyon, R. [Robotics and Virtual Reality: A Perfect Marriage for Motor Control Research and Rehabilitation](#). IEEE Engineering in Medicine and Biology Society Conference (EMBS), pp:4840-4843, San Francisco, CA, USA, 2004.
18. Keshner, EA., Kenyon, RV., Dhaher, Y. [Using Immersive Technology for Postural Research and Rehabilitation](#), 26th Intern. Conf IEEE EMBS, pp: 4862-4865, San Francisco, September 1-5, 2004.
19. Kenyon, RV., Leigh, J., [Networked Virtual Environments and Rehabilitation](#), 26th Intern. Conf IEEE EMBS, pp: 4832-4835, San Francisco, September 1-5, 2004.
20. Keshner, E.A., Kenyon, R.V. (2005). Visual context affects postural strategies in healthy and labyrinthine deficient elderly. International Society for Posture and Gait Research, Marseilles, France, May 29-June 2, 2005.
21. Kenyon, R.V., Gurses, S., Keshner, E.A. (2005). Determining the effects of visual and self-motion inputs on intersegmental postural responses. International Society for Posture and Gait Research, Marseilles, France, May 29-June 2, 2005
22. Scharver, C, Patton, J, Kenyon, R, Kersten, E (2005) [Comparing adaptation of constrained and unconstrained movements in three dimensions](#), Proceedings of 2005 International Conference on Rehabilitation Robotics, pp: 434-439, Chicago, IL . 28 June-1 July 2005
23. Luo, X., Kline, T., Fischer, H.C., Stubblefield, K.A., Kenyon, R.V., Kamper, D.G. [Integration of Augmented Reality and Assistive Devices for Post-Stroke Hand Opening Rehabilitation](#). 27th Intern. Conf IEEE EMBS, Sept 1-4., pp: 6855-6858, Shanghai, China, 2005.
24. X. Luo, R. V. Kenyon, D. G. Kamper. [An Augmented Reality Training Environment for Post-Stroke Finger Extension Rehabilitation](#). In: IEEE-International Conference on Rehabilitation Robotics, pp: 329 - 332, Chicago, IL, 28 June-1 July 2005
25. Patton, J.L., Wei, Y., Scharver, C., Kenyon, R.V., Scheidt, R., (2006) [Motivating Rehabilitation by Distorting Reality](#), BioRob 2006: The first IEEE / RAS-EMBS International Conference on Biomedical Robotics and Biomechatronics, Pisa, Tuscany, Italy, pp. 869 – 874, February 20-22, 2006.
26. Dvorkin A.Y., Kenyon R.V. & Keshner E.A. (2006) [Reaching within a dynamic virtual environment](#). In: IEEE 5th International Workshop on Virtual Rehabilitation. p. 182-186, NY, Aug. 2006.

27. Luo, Xun, Kenyon, R., Kamper, D., Sandin, D., DeFanti, T. "[The Effects of Scene Complexity, Stereovision, and Motion Parallax on Size Constancy in a Virtual Environment](#)," IEEE Virtual Reality Conference, 2007. VR '07, pp.59-66, 10-14 March 2007.
28. Dokka K, .Keshner EA, and Kenyon RV. [Influence of visual and support surface velocities on head position](#). International Society for Posture and Gait Research, p. 121, Vermont, July 14-18, 2007.
29. Wang, Yun; Kenyon, R.V.; Keshner, E.A., "[Virtual scene velocity influences postural responses to an inclined base of support](#)," Virtual Rehabilitation, pp.41-44, 25-27 Aug. 2008
30. Rozario S, Housman S, Kovic M, Kenyon R, Patton J. [Therapist-mediated post-stroke rehabilitation using haptic/graphic error augmentation](#). In: IEEE Engineering In Medicine and Biology Conference (EMBC), Minneapolis, MN, USA, 2009:1151-6, 2009.
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6. Parker, A.J., and Kenyon, R.V.: Comparison of interpolating methods for image resampling. Presented at Society of Nuclear Medicine, St. Louis, MO, June 1983.
7. Kenyon, R.V., Becker, J.T., Butters, N. and Hermann, H.: Oculomotor function in alcoholic Korsakoff's syndrome, Presented at Society for Neurosciences, Boston, MA, October 1983.
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14. Kenyon, RV and Keshner, EA. Segmental Postural Stabilizing Responses in an Immersive Virtual Environment. Presented at Society for Neurosciences, New Orleans, LA, November 4 - 9, 2000.
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21. Patton JL and Kenyon R, Robotic Neurorehabilitation using State-of-the-art Robotics and Augmented Reality Displays, Invited talk at the Rehabilitation Engineering Society of North America (RESNA) Research Symposium on Use of Virtual & Augmented Reality in Rehabilitation Research and Clinical Practice, Atlanta, June. 2003.
22. Patton JL, Kenyon R, Exploiting the adaptive tendencies of the nervous system for rehabilitation of brain injury: the PARIS-Robotic system, Rehabilitation Engineering Society of North America (RESNA), Atlanta, June, 2003.
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30. Wang Y, Kenyon, RV, Keshner, EA. Virtual Scene Velocity Influences Postural Responses to an Inclined Base of Support. Virtual Rehabilitation 2008, Vancouver, CAN, August 25-27, 2008.
31. Abodollahi, F, Kenyon, R. Speed Perception and the Leibowitz Hypothesis. IEEE EMBS, 2008 St. Louis, MO. [Poster]
32. J. Novak, J. Archer, V. Shafiro, R. Kenyon, J. Leigh. On-line audio dilation for interactive speech communication. Midwest Speech and Language Days. Toyota Technological Institute at Chicago May 2-3, 2013 [Demonstration]

#### **Invited Lectures**

1. Effects and Side Effects of Rehabilitating with Virtual Reality; MIT Lincoln Labs, 1/23/2017.
2. Virtual Reality with Prof Bob Kenyon; Princeton University Precept @ EVL, University of Illinois at Chicago, 10/18/2016.
3. Star Wars to “Star-Light”: The Electronic Visualization Laboratory [EVL], March 18, 2015 Department of Aeronautics and Astronautics Massachusetts Institute of Technology
4. Star Wars to “Star-Light”: Human Factors and EVL, February 12, 2015 Man-Vehicle Laboratory Massachusetts Institute of Technology
5. The CAVE: Can you believe what you see in Virtual Environments, March 18, 2015 Massachusetts Eye and Ear Infirmary, Harvard University
6. Star Wars to “Star-Light”:the Electronic Visualization Laboratory [EVL], May 1, 2015 Department of Ecology and Evolutionary Biology Princeton University
7. Visualizing the Invisible: Encouraging Motivation, August 26, 2014 Northwestern University’s Medical campus, Workshop
8. E2-Sense: Electronic Enhancement of Sensory Dead Space. Defense Science Research

Council. Arlington, VA. 3/28/2013

9. "Size Constancy in the CAVE". University of Pennsylvania, Philadelphia, October, 2007.
10. "Size Constancy in the CAVE". Virtual Images Seminar, CNRS: College de France & Renault Corp, Paris, France, June, 2006.
11. "Size Constancy in the CAVE". ETH and University Zurich, Zurich, Switzerland, June, 2006.
12. "Size Constancy in the CAVE". Laboratoire de Mouvement et Perception, Université de la Méditerranée, Marseilles, France, May, 2006.
13. "Size Constancy in the CAVE". Institut de Psychologie Université Paris V, René Descartes, Paris, France, March, 2006.
14. "Size Constancy in the CAVE". Laboratoire de Physiologie de la Perception et de l'Action, College de France, Paris, France, February 2006.
15. "Size Constancy in the CAVE". Man-Vehicle Laboratory, MIT, September, 2006.
16. "Virtual Reality and Machines: Research and Rehabilitation". Human Motion Simulation Laboratory, University of Michigan, November 16, 2005.
17. The 4th International Symposium on Future Medical Engineering based on Bio-nanotechnology, Sendai, Japan, June 25, 2004.
18. Fostering Inter-Connectivity Of Health Informatics at UIC, *Human factors and Graphics*, Chicago, IL, February 26, 2002
19. Chairman, *State of the Science Conference: VR-Haptics: Environments and Advanced Interface Technologies*, National Rehabilitation Hospital, Washington, DC, October 12-13, 2001.
20. Medical Rehabilitation on the Move - Spotlight on Bioengineering. Sponsor: National Center for Medical Rehabilitation Research (NCMRR) of NICHD, Washington DC, January 4-5, 2001.
21. Rehabilitation Institute of Chicago "Segmental Postural Stabilizing Responses in an Immersive Virtual Environment", Chicago, IL., 2000
22. General Motors Research & Development Virtual Environments Laboratory Workshop: Perception in Surround-Screen Stereoscopic Display Systems, "Hitting 3-D Targets in the CAVE", Warren Mi., October 1999.
23. IEEE EMBS Workshop: Virtual Reality in Medicine, "Virtual Environment Characteristics for Training Transfer", 1997 International IEEE Engineering Medicine and Biology Conference, Chicago, 1997.
24. "Virtual Environments for Engineering Education". The Annual Pathfinder Conference, Ohio Aerospace Institute, Cleveland, OH., August 21 - 22, 1997.
25. Cambridge Basic Research, Nissan Inc. "The Use of Virtual Environments for Research and Design". Cambridge, MA. February 1997.
26. USAF Armstrong Aerospace Med. Res. LAB, Wright-Patterson, "The Mandelbaum Effect and Accommodation". AFB, OH, August. 1996.
27. USAF Armstrong Aerospace Med. Res. LAB, Wright-Patterson, "Visual Requirements

for Virtual Environment Generation". AFB, OH, March. 1996.

28. "Synesthesia", Presented at SuperComputing '95 International Meeting, San Diego, December, 1995.
29. Meta-Generics Limited, "The CAVE Virtual Environment". Cambridge, England, July, 1995.
30. Identica Limited, "Design using Virtual Environments". London, England, June, 1995.
31. Queen Mary and Westfield College, "Training in Virtual Environments". London, England, May 1995.
32. Workshop on Future Directions of Human-Computer Interaction, "The CAVE Automatic Virtual Environment: Characteristics and Applications", April 25-27, Hampton, VA, 1995.

### **Biographical Sketch**

Professor Kenyon received his B.S. degree in Electrical Engineering from the University of Rhode Island, in 1970, a M.S. degree in Bioengineering from the University of Illinois Chicago, in 1972, and a Ph.D. in Physiological Optics from the University of California, Berkeley, in 1978. From 1979 to 1986, he was a faculty member of the Department of Aeronautics and Astronautics at the Massachusetts Institute of Technology, Cambridge and Harvard Medical School - Whitaker Health Sciences and Technology Joint Programs. He is currently a Professor Emeritus at the University of Illinois Chicago. From 2000-2002 he was a visiting Associate Professor at the University of Washington, Seattle. In 2006, he was a visiting Research Associate at the College de France, Laboratoire de Physiologie de la Perception et de l'Action, working with Prof. Alain Berthoz. In 2015, he was a visiting Professor at MIT in the Man-Vehicle Laboratory. His research has spanned the areas of sensory-motor adaptation, effects of micro-gravity on vestibular development, visuo-motor and posture control, flight simulation, virtual environments, computer graphics, Tele-immersion and sensory/motor integration, adaptation to the use of wearable technology and rehabilitation of sensory/motor systems following stroke and traumatic brain injury.

While at MIT he was a collaborator on several Space Shuttle experiments that studied the effects of micro-gravity on human/animal orientation: Spacelab-1, German Space-lab (D-1), and STS-29 ("Chix in Space"). He also developed and delivered an interactive visual display system to produce simulator-like experiences for AF pilots undergoing training at Brooks AFB centrifuge and disorientation trainers. For this AF funded research, both hardware and software were designed to present the pilots with an interactive wide-field-of-view computer-generated imagery superior to the then current day head mounted displays. He also was co-originator, director, and one of the three instructors that taught one of the first flight simulator courses in the country designed for professionals (MIT's summer session program).

His work at UIC has concentrated on virtual environments (VEs) with his involvement with the CAVE. He was co-PI on two NSF grants that were instrumental in the development of the CAVE and a co-author of the first paper describing the CAVE. He also has been a major contributor to understanding how limitations of a VE system (such as the CAVE) can affect

human behavior. Other work has examined human performance in VEs and how to quantify the use of VEs for training and collaboration. This work was performed using stand-alone CAVE applications and also in-networked (i.e., tele-immersive) applications using a variety of networks from ISDN to the then latest international networks (STARTAP). Some of this work has been specifically aimed at analyzing and improving the performance of distributed VEs themselves by understanding the characteristics of the connecting networks and modeling both the CAVE and the network using Petri-nets. Other modeling work focused on humans where he and his students developed a system identification tool based on Kalman filters that can be used to estimate, in real-time, the delay and model coefficients of a human operator to investigate how these characteristics change as the operator's environment is changed with time.

His work on applications of VE to biocybernetics, which was carried out at the Rehabilitation Institute of Chicago [now called The Sherly Ryan Ability Center], involves the coupling of robots to VE and the integration of visual and motion information to maintain erect posture. The VE-Robot systems were used to explore new methods that would aid in the rehabilitation of stroke survivors. His area of research also included Human Augmentics [HA]: research and development of technologies that can expand the capabilities and enhance the characteristics of human biological systems. This research included investigating how information from external sensors providing visual and kinesthetic information can be utilized to understand novel environments where both seen and unseen objects can be sensed.

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