Ronald T. Azuma, Ph.D.

C.V.

Personal email: ronald.azuma@gmail.com
http://www.ronaldazuma.com
Home: San Jose, CA

Education

University of North Carolina, Chapel Hill, NC
Ph.D. in Computer Science, May 1995
M.S. in Computer Science, May 1990 (Pogue fellowship)

University of California, Berkeley, CA
B.S. in Electrical Engineering / Computer Science, May 1988
With highest honors. Chancellor's and National Merit scholarships.

Experience

Principal Engineer and Research Manager, Intel Labs (Santa Clara, CA)
4/16 – present
Augmented Reality Leader, Intel Labs (Santa Clara, CA)
6/12 – 3/16

Line Management, Technical Leadership and Prototyping: I lead a team pursuing key enabling technologies for new forms of media, including AR and VR, along with prototyping novel experiences. These enabling technologies include computational displays, head-worn displays, and computational imaging. I also advise Intel on Augmented Reality and other related technologies and experiences.

Computational Displays: Led research efforts to make light field displays more practical. Light field displays reduce eyestrain in 3D displays by enabling the viewer to focus to different depths.

ThinVR: A computational display approach to simultaneously achieve 180 degree horizontal field-of-view and a compact form factor in a VR display. Published at IEEE Virtual Reality 2020 as an IEEE TVCG journal paper and demonstrated at SIGGRAPH 2020. I was the research manager on this project and provided technical direction for the execution.

Mid-Air Interaction with a 3D Aerial Display: Managed the team that built and demonstrated a 3D display that looks like an interactive, touchable hologram. Demoed at SIGGRAPH 2017.

Leviathan: I personally implemented part of the Leviathan Augmented Reality demonstrations that Intel showed at CES 2014 to inspire new forms of Augmented Reality storytelling. I also directed my team to build the AR framework that enabled the demonstration in the Intel CEO keynote presentation. I served as the main Intel technical expert on this project.

Research Leader, Nokia Research Center Hollywood (Santa Monica, CA)
10/08 – 1/12

Line Management: Helped build a new research laboratory focused on novel media and entertainment applications, by establishing a new environment and culture, and by recruiting and leading a team to develop new forms of mobile pervasive media.

Project Management: Supervised two research focus areas: 1) Developing a new approach to implement a mobile AR experience that provides a more compelling experience than AR browsers offered, and 2) Exploring the use of pervasive computing technologies combined with mobile devices to enable novel forms of mobile media and experiences.

The Westwood Experience: My team built this novel location-based experience that was an experiment in connecting a narrative to evocative locations via Mixed Reality.

Sr. Research Staff Computer Scientist, HRL Laboratories (Malibu, CA)
11/99 – 10/08
Research Staff Member, HRL / Hughes Research Laboratories (Malibu, CA)
3/95 – 11/99

Project Leadership: Principal Investigator of two DARPA projects and numerous Raytheon, Boeing and GM internal projects in visualization, tracking, and Augmented Reality.

Augmented Reality: Demonstrated the first motion-stabilized outdoor Augmented Reality display. Built a new algorithm for automatically positioning AR labels over real-world objects to avoid occlusions. Demonstrated a basic perception problem in "x-ray vision" in AR visualizations. Active participant in running the IEEE ISMAR conference (serving as program and area chair multiple times).

Visualization: Developed interactive visualization techniques for future "Free Flight" Air Traffic Control applications. Demonstrated them at the ATCA '95, '96 and '98 conventions. Worked on visualization displays for battlefield awareness and time-critical decision making. Examined the application of autostereoscopic displays. Developed non-geographic visualization techniques to generate insight from National Airspace System simulation data. Collaborated with computer vision experts by building visualization tools and designing the software infrastructure to support research in the semantic recognition of objects (buildings, cars, trees, etc.) from dense urban LIDAR data.

Virtual Environments: Built part of a car simulator to investigate the effectiveness of multimodal warnings from Crash Avoidance sensors. Built large head-tracked stereo displays.

Research Assistant, UNC Chapel Hill
5/89 – 2/95

Augmented Reality: Demonstrated the first compelling example of virtual-real registration in an optical see-through display. Developed inertial-based predictive trackers and calibration techniques. Built a see-through Head-Mounted Display system to demonstrate and evaluate these techniques. Reduced registration errors by a factor of 5-10. Published work in two SIGGRAPH papers.

Human Tracking: Built a novel outward-looking optoelectronic tracking system that was the first demonstrated scalable tracker for Head-Mounted Displays (shown at SIGGRAPH '91). This was a team effort; my contributions included designing and simulating the overall software architecture, developing and coding the mathematics that compute head locations given sensor inputs, and calibrating the optical sensors. The HiBall tracker sold by 3rdTech is a descendent of this system.

Instructor, UNC Chapel Hill
Summer 1992

Completely redesigned and taught undergraduate “Computers and Society” course.

Software Engineer, Apple Computer (summer internships)
Summers of 1986 - 1988

Investigated image compression, wrote AppleTalk file transfer and test programs.

Skills

- Augmented Reality. Extensive knowledge and background in Augmented Reality systems.
- Head-worn displays: 25 years of experience with a wide variety of head-worn display systems, particularly in optical see-through head-worn displays.
- Line and project management, team leadership
- Public speaking and communication
- Development platforms: Windows and Linux. In the past I have also used Macintosh, UNIX and other platforms.
- Languages: C/C++ and JavaScript are the languages I have used most recently. In the past I have also programmed in a variety of other languages.
- Qt, OpenSceneGraph
- Government contract fundraising

Publications

Ronald Azuma. *Foreword to the Springer Handbook of Augmented Reality.* To be published in the Springer Handbook of Augmented Reality (expected 2022), 1 page.

Li, Tuotuo, Qiong Huang, Santiago Alfaro, Alexey Supikov, Joshua Ratcliff, Ginni Grover, and Ronald Azuma. Light-Field Displays: a View-Dependent Approach. In *Special Interest Group on Computer Graphics and Interactive Techniques Conference Emerging Technologies (SIGGRAPH '20 Emerging Technologies),* August 17, 2020, ACM, New York, NY, USA, 2 pages. DOI 10.1145/3388534.3407293

Ratcliff, Joshua, Alexey Supikov, Santiago Alfaro, and Ronald Azuma. ThinVR: VR displays with wide FOV in a compact form factor. In *Special Interest Group on Computer Graphics and Interactive Techniques Conference Emerging Technologies (SIGGRAPH '20 Emerging Technologies),* August 17, 2020, ACM, New York, NY, USA, 2 pages. DOI 10.1145/3388534.3407302

Li, Tuotuo, Qiong Huang, Santiago Alfaro, Alexey Supikov, Ronald Azuma. View-Dependent Light-Field Display that Supports Accommodation Using a Commercially-Available High Pixel Density LCD Panel. *Display Week 2020* (San Jose, 3-7 August 2020).

Ratcliff, Joshua, Alexey Supikov, Santiago Alfaro, Ronald Azuma. ThinVR: Heterogeneous microlens arrays for compact, 180 degree FOV VR near-eye displays. *IEEE Transactions on Visualization and Computer Graphics,* vol. 26, #5 (May 2020), pp. 1981-1990. Presented at *IEEE Virtual Reality 2020* (Atlanta, GA, 22-26 March 2020). **Best Paper award at IEEE VR 2020.** DOI 10.1109/TVCG.2020.2973064

Grover, Ginni, Oscar Nestares, and Ronald Azuma. Understanding ability of 3D Integral displays to provide accurate out-of-focus retinal blur. *IS&T Proceedings of Electronic Imaging 2019, 30th Annual Stereoscopic Displays and Applications conference* (San Francisco, CA, 14-16 January 2019), pp. 635-1-635-9(9).

Azuma, Ronald T. The Road to Ubiquitous Consumer Augmented Reality Systems. *Human Behavior and Emerging Technologies* vol. 1, #1 (January 2019), pp. 26-32. https://doi.org/10.1002/hbe2.113

Hunter, Seth, Ron Azuma, Jonathan Moisant-Thompson, Dave MacLeod, Derek Disanjh. Mid-Air Interaction with a 3D Aerial Display. *Proceedings of SIGGRAPH 2017 Emerging Technology Installation* (Los Angeles, 30 July – 3 August 2017), 2 pages.

Azuma, Ronald T. Making Augmented Reality a Reality. *Proceedings of OSA Imaging and Applied Optics Congress 2017* (San Francisco, CA, 25-29 June 2017).

Azuma, Ronald T. The Most Important Challenge Facing Augmented Reality. *Presence: Teleoperators and Virtual Environments 25,* #3 (Summer 2016), pp. 234-238. Publication date January 31, 2017.

Azuma, Ronald. Location-Based Mixed and Augmented Reality Storytelling. Book chapter in *Fundamentals of Wearable Computers and Augmented Reality, 2nd Edition,* Woodrow Barfield, editor. CRC Press, August 2015, pp. 259-279.

Xu, Yan, Joshua Ratcliff, James Scovell, Gheric Speiginer, Ronald Azuma. Real-time Guidance Camera Interface to Enhance Photo Aesthetic Quality. *Proc. ACM CHI 2015* (Seoul, Korea, 18-23 April 2015), pp. 1183-1186.

Azuma, Ronald. Augmented Reality Systems. Book chapter to be published in *Second edition of Handbook of Visual Display Technology,* Janglin Chen, Wayne Cranton and Mark Fihn, editors. Springer Science and Business Media, 2015.

Laibowitz, Mat, Vids Samanta, Syed Reza Ali, Ronald Azuma. Chamber of Mirrors: A Socially Activated Game Exploits Pervasive Technology. *IEEE Pervasive Computing,* vol. 11, #2 (April – June 2012), pp. 38–45.

Wither, Jason, Sean White, Ronald Azuma. Comparing Spatial Understanding Between Touch-Based and AR-Style Interaction. *Proc. IEEE Int'l Symp. on Mixed and Augmented Reality (ISMAR 2011)* (Basel, Switzerland, 26-29 Oct. 2011), pp. 273-274.

Azuma, Ronald, Mark Billinghurst, Gudrun Klinker. Special Section on Mobile Augmented Reality. *Computers & Graphics, vol. 35, #4* (August 2011), pp. vii-viii. Special issue on Mobile Augmented Reality.

Wither, Jason, Yun-Ta Tsai, Ronald Azuma. Indirect Augmented Reality. *Computers & Graphics, vol. 35, #4* (August 2011). Special issue on Mobile Augmented Reality. pp. 810-822.

Korah, Thommen, Jason Wither, Yun-Ta Tsai, Ronald Azuma. Mobile Augmented Reality at the Hollywood Walk of Fame. *Proc. of IEEE Virtual Reality 2011* (Singapore, 19-23 March 2011), pp. 183-186.

Wither, Jason, Rebecca Allen, Vids Samanta, Juha Hemanus, Yun-Ta Tsai, Ronald Azuma, Will Carter, Rachel Hinman, Thommen Korah. The Westwood Experience: Connecting Story to Locations Via Mixed Reality. *IEEE International Symposium on Mixed and Augmented Reality 2010, Arts, Media and Humanities Proceedings (ISMAR AMH 2010)* (Seoul, Korea, 13-16 Oct. 2010), pp. 39-46.

Livingston, Mark, Ronald Azuma, Oliver Bimber, Hideo Saito. Guest Editors' Introduction: Special Section on The International Symposium on Mixed and Augmented Reality (ISMAR). *IEEE Trans. on Visualization and Computer Graphics*, vol. 16, #3 (2010), pp. 353-354.

Ronald Azuma, Howard Neely III, Mike Daily, Jon Leonard. Performance Analysis of an Outdoor Augmented Reality Tracking System that Relies Upon a Few Mobile Beacons. *Proc. IEEE and ACM Int'l Symp. on Mixed and Augmented Reality (ISMAR 2006)* (Santa Barbara, CA, 22-25 Oct. 2006), pp. 101-104.

Mike Daily, Ron Azuma, Youngkwan Cho, Troy Rockwood, and Susan Gottschlich. Tactial Alert Management. *Proc. 2006 Int'l Conf. on Artificial Intelligence (ICAI '06)* (Las Vegas, NV, 26-29 June 2006), pp. 337-343.

Ron Azuma, Mike Daily, Chris Furmanski. A Review of Time Critical Decision Making Models and Human Cognitive Processes. *Proc. 2006 IEEE Aerospace Conference* (Big Sky, MT, 4-11 March 2006).

Ronald Azuma, Jason Fox, and Chris Furmanski. Evaluating Visualization Modes for Closely-Spaced Parallel Approaches. *Proc. HFES 49th Annual Meeting* (Orlando, FL, 26-30 Sept. 2005), pp. 35-39.

Ronald Azuma, Tim Clausner, Mike Daily, Jason Fox, and Mary E. Miller. Visualization Concepts for Generating Insight from NAS Simulation Data. *Proc. AIAA 2005 Modeling and Simulation Conference* (San Francisco, 15-18 Aug. 2005)

Ronald Azuma, Chris Furmanski. Evaluating Label Placement for Augmented Reality View Management. *Proc. IEEE and ACM Int'l Symp. on Mixed and Augmented Reality (ISMAR 2003)* (Tokyo, 7-10 Oct. 2003), pp. 66-75.

Chris Furmanski, Ronald Azuma, Mike Daily. Augmented-reality visualizations guided by cognition: Perceptual heuristics for combining visible and obscured information. *Proc. IEEE and ACM Int'l Symp. on Mixed and Augmented Reality (ISMAR 2002)* (Darmstadt, Germany, 30 Sept. - 1 Oct. 2002), pp. 215-224.

Ronald Azuma, Yohan Baillot, Reinhold Behringer, Steven Feiner, Simon Julier, Blair MacIntyre. Recent Advances in Augmented Reality. *IEEE Computer Graphics and Applications 21*, 6 (Nov/Dec 2001), 34-47.

Azuma, Ronald T. Augmented Reality: Approaches and Technical Challenges. Book chapter in *Fundamentals of Wearable Computers and Augmented Reality,* Woodrow Barfield and Thomas Caudell, editors. Lawrence Erlbaum Associates, 2001, ISBN 0-8058-2901-6. Chapter 2, pp. 27-63.

Bruce Hoff, Ronald Azuma. Autocalibration of an Electronic Compass in an Outdoor Augmented Reality System. *Proc. of Int'l Symp. on Augmented Reality 2000* (Munich, Germany, 5-6 Oct. 2000), pp. 159-164.

Ronald Azuma, Howard Neely III, Michael Daily, Ryan Geiss. Visualization Tools for Free Flight Air-Traffic Management. *IEEE Computer Graphics and Applications 20*, 5 (Sept/Oct 2000), 32-36.

Azuma, Ronald, Jong Weon Lee, Bolan Jiang, Jun Park, Suya You, and Ulrich Neumann. Tracking in unprepared environments for augmented reality systems. *Computers & Graphics 23,* 6 (December 1999), 787-793.

You, Suya, Ulrich Neumann, and Ronald Azuma. Orientation Tracking for Outdoor Augmented Reality Registration. *IEEE Computer Graphics and Applications 19*, 6 (Nov/Dec 1999), 36-42.

Azuma, Ronald, Howard Neely III, Mike Daily, Mario Correa. Visualization of Conflicts and Resolutions in a "Free Flight" Scenario. *Proc. of IEEE Visualization '99* (San Francisco, 24-29 Oct. 1999), pp. 433-436, 557.

Azuma, Ronald, Bruce Hoff, Howard Neely III, Ron Sarfaty. A Motion-Stabilized Outdoor Augmented Reality System. *Proc. of IEEE Virtual Reality '99* (Houston, TX, 13-17 March 1999), pp. 252-259.

You, Suya, Ulrich Neumann, and Ronald Azuma. Hybrid Inertial and Vision Tracking for Augmented Reality Registration. *Proc. of IEEE Virtual Reality '99* (Houston, TX, 13-17 March 1999), pp. 260-267.

Azuma, Ronald T. The Challenge of Making Augmented Reality Work Outdoors. Book chapter in *Mixed Reality: Merging Real and Virtual Worlds,* Yuichi Ohta and Hideyuki Tamura, editors. Springer-Verlag, 1999, ISBN 3-540-65623-5. Chapter 21, pp. 379-390. Associated with

invited presentation at *First Int'l Symp. on Mixed Reality (ISMR 1999)* (Yokohama, Japan, 9-11 March 1999).

Azuma, Ronald T., Bruce R. Hoff, Howard E. Neely III, Ronald Sarfaty, Michael J. Daily, Gary Bishop, Vern Chi, Greg Welch, Ulrich Neumann, Suya You, Rich Nichols, and Jim Cannon. Making Augmented Reality Work Outdoors Requires Hybrid Tracking. *Proc. of First Int'l Workshop on Augmented Reality* (San Francisco, 1 Nov. 1998), pp. 219-224.

Azuma, Ronald T. A Survey of Augmented Reality. *Presence: Teleoperators and Virtual Environments 6,* 4 (August 1997), pp. 355 - 385. Earlier version appeared in Course Notes #9: Developing Advanced Virtual Reality Applications, *ACM SIGGRAPH '95* (Los Angeles, 6-11 August 1995), 20-1 to 20-38. **The most referenced publication in the field of AR. One of 50 influential journal articles selected by MIT Press, from over 80 MIT Press journals from 1969 to 2011, covering all academic fields.**

Azuma, Ronald T. Course notes on "Registration" and "Correcting for Dynamic Error" from Course Notes #30: Making Direct Manipulation Work in Virtual Reality. *ACM SIGGRAPH '97* (Los Angeles, 3-8 Aug. 1997).

Azuma, Ronald, Mike Daily, and Jimmy Krozel. Advanced Human-Computer Interfaces for Air Traffic Management and Simulation. *Proc. of 1996 AIAA Flight Simulation Technologies Conference* (San Diego, CA, 29-31 July 1996), pp. 656-666. **Awarded Best Paper of conference.**

Daily, Mike, Ronald Azuma, Pete Tinker, Kevin Martin, and Cheryl Hein. Soldier System Effectiveness Measurement System Virtual Environments Study. Hughes Studies and Analysis Technical Report (July 1996).

Tinker, Pete, Ronald Azuma, Cheryl Hein, and Mike Daily. Driving Simulation for Crash Avoidance Warning Evaluation. *Proc. of 29th ISATA Dedicated Conference on Simulation, Diagnosis and Virtual Reality.* (Florence, Italy, 3-6 June 1996), pp. 367-374.

Azuma, Ronald and Gary Bishop. A Frequency-Domain Analysis of Head-Motion Prediction. *Proc. of ACM SIGGRAPH '95* (Los Angeles, 6-11 August 1995). *Computer Graphics,* Annual Conference Series, 1995, 401-408.

Dissertation: Predictive Tracking for Augmented Reality. UNC Chapel Hill Dept. of Computer Science technical report TR95-008 (February 1995), 262 pages.

Azuma, Ronald and Gary Bishop. Improving Static and Dynamic Registration in an Optical See-Through HMD. *Proc. of ACM SIGGRAPH '94* (Orlando, FL, 24-29 July 1994), *Computer Graphics,* Annual Conference Series, 1994, 197-204 + CD-ROM appendix

Azuma, Ronald. Tracking Requirements for Augmented Reality. *Communications of the ACM 36,* 7 (July 1993), 50-51.

Ward, Mark, Ronald Azuma, Robert Bennett, Stefan Gottschalk, and Henry Fuchs. A Demonstrated Optical Tracker With Scalable Work Area for Head-Mounted Display Systems. *Proc. of 1992 Symp. on Interactive 3D Graphics* (Cambridge, MA, 29 March - 1 April 1992), pp. 43-52.

Azuma, Ronald and Mark Ward. Space-Resection by Collinearity: Mathematics Behind the Optical Ceiling Head-Tracker. UNC Chapel Hill Department of Computer Science technical report TR 91-048 (November 1991), 23 pages.

Wang, Jih-Fang, Ronald Azuma, Gary Bishop, Vern Chi, John Eyles, and Henry Fuchs. Tracking a Head-Mounted Display in a Room-Sized Environment with Head-Mounted Cameras. SPIE Proceedings Vol. 1290 Helmet-Mounted Displays II (Orlando, FL, 19-20 April 1990), pp. 47-57.

Patents

US 11,009,766. **Foveated virtual reality near eye displays.** Ginni Grover, Ronald Azuma, Oscar Nestares. Issued May 18, 2021.

US 10,939,085. **Three dimensional glasses free light field display using eye location.** Tuotuo Li, Joshua J Ratcliff, Qiong Huang, Alexey M Supikov, Ronald T Azuma. Issued March 2, 2021.

US 10,928,639. **Thin, multi-focal plane, augmented reality eyewear.** Sabine Roessel, Ronald Azuma, Mario Palumbo. Issued Feb. 23, 2021.

US 10,284,816. **Facilitating true three-dimensional virtual representation of real objects using dynamic three-dimensional shapes.** Ronald T. Azuma. Issued May 7, 2019.

US 9,317,133. **Method and apparatus for generating augmented reality content.** Thommen Korah, Ronald Azuma. Issued April 16, 2016.

US 9,262,696. **Image capture feedback.** Joshua Ratcliff, Ronald Azuma, Yan Xu, Gheric Speiginer. Issued February 16, 2016.

US 9,122,707. **Method and apparatus for providing a localized virtual reality environment.** Jason Wither, Ronald Azuma. Issued September 1, 2015.

US 8,838,381. **Automatic video generation for navigation and object finding.** Michael Daily, Ronald Azuma. Issued September 16, 2014.

US 8,515,126. **Multi-stage method for object detection using cognitive swarms and system for automated response to detected objects.** Swarup Medasani, Yuri Owechko, Michael Daily, Ronald Azuma. Issued August 20, 2013.

US 8,488,877. **System for object recognition in colorized point clouds.** Yuri Owechko, Swarup Medasani, Ronald Azuma, Jim Nelson. Issued July 16, 2013.

US 8,335,751. **System for intelligent goal-directed search in large volume imagery and video using a cognitive-neural subsystem.** Michael Daily, Deepak Khosla, Ronald Azuma. Issued Dec. 18, 2012.

US 8,081,088. **Method and apparatus for apportioning attention to status indicators**. Timothy C. Clausner, Ronald T. Azuma. Issued Dec. 20, 2011.

US 7,796,155. **Method and apparatus for real-time group interactive augmented-reality area monitoring, suitable for enhancing the enjoyment of entertainment events**. Howard Neely III, Ronald T. Azuma, Jerry Isdale, Mike Daily. Issued Sept. 14, 2010.

US 7,599,789. **Beacon-augmented pose estimation.** Jon Leonard, Howard Neely III, Ron Azuma, Mike Daily. Issued Oct. 6, 2009.

US 7,315,241. **Enhanced Perception Lighting.** Mike Daily, Ron Azuma, Chris Furmanski. Issued Jan. 1, 2008.

US 7,131,060. **System and Method for Automatic Placement of Labels for Interactive Graphics Applications.** Ronald Azuma. Issued Oct. 31, 2006.

US 7,120,875. **Augmented Reality Hybrid Tracking System with Fiducial-Based Heading Correction.** Michael Daily, Ronald Azuma, Howard Neely III, Gerald Isdale. Issued Oct. 10, 2006.

US 7,002,551. **An Optical See-Through Augmented Reality Modified-Scale Display.** Ronald Azuma, Ron Sarfaty. Issued Feb. 21, 2006.

US 6,577,976. **Real-Time Sensor Autocalibration for a Multi-Sensor Inertial Tracking System.** Bruce Hoff, Ronald Azuma. Issued June 10, 2003.

US 6,408,251. **Calibrating a Magnetic Compass With an Angular Rate Gyroscope and a Global Positioning Receiver.** Ronald Azuma. Issued June 18, 2002.

Invited Presentations

Invited speaker at the SPIE AR VR MR Conference 2020 at Photonics West 2020 (4 February 2020, San Francisco).

Invited talk at the Augmented, Virtual and Mixed Reality Conference 2019 at Photonics West 2019 (3 February 2019, San Francisco).

Plenary talk at the IS&T International Symposium on Electronic Imaging 2018 (31 January 2018, Burlingame, CA).

Invited talk at the AR, VR, MR One-Day Industry Conference at Photonics West 2018 (29 January 2018, San Francisco).

Invited speaker at the OSA Imaging and Applied Optics Congress 2017 (25-29 June 2017, San Francisco).

Morning keynote at the AR/VR Conference at SID Display Week 2017 (May 24, 2017, Los Angeles).

Featured speaker at the Stanford SCIEN workshop on Augmented and Mixed Reality (May 11, 2017).

Opening presentation for the Applied Materials Open Innovation Workshop on Next Generation Hardware for Augmented and Virtual Reality (August 4, 2016).

Keynote at VARE 2015 (Virtual and Augmented Reality in Education) (19-21 Nov. 2015, Monterrey, Mexico)

Metaio's InsideAR event (Oct. 2014, Munich, Germany)

National Academy of Engineering Gilbreth Lecture (Feb. 2013, Irvine, CA)

HRL colloquium (Mar. 2012, Malibu, CA)

DTS tech talk (Feb. 2012, Calabasas, CA)

Google TechTalk (Sept. 2011, Mtn. View, CA)

eComm 2011 (June 2011, SFO Marriott)

Total Immersion's *"AR Immersion 2010"* event (June 2010, Los Angeles)

International Game/Film Lounge 2010 (Los Angeles)

Virtual Reality and Software Technologies 2000 (Seoul, South Korea)

First International Symposium on Mixed Reality (ISMR '99), Yokohama, Japan

5th Eurographics Workshop on Virtual Environments (with a special focus on AR), Vienna, Austria (June 1999).

Workshop on Wearable Computer Systems (Aug. 1996, Seattle, WA)

Other Presentations

Guest lecturer at Stanford CS377M: HCI Issues in Mixed and Augmented Reality (May 2, 2016)

Leviathan: Inspiring new forms of storytelling via Augmented Reality (Augmented World Expo, May 2014, Santa Clara, CA)

Panels

Panel at the Augmented, Virtual and Mixed Reality Conference 2019 (Photonics West, 4 February 2019, San Francisco)

Panel at VR, AR, MR One-Day Industry Conference (Photonics West, 29 January 2018, San Francisco, CA)

AR-VR: There Yet? (Intel Capital Global Summit 2015, 2-4 Nov. 2015, San Diego, CA)

The Renaissance of VR: Are We Going to Do it Right This Time? (SIGGRAPH 2015, 9-13 August 2015, Los Angeles)

The Next Ten Years of AR. (IEEE ISMAR 2008, 15-18 Sept. 2008, Cambridge, UK)

Demonstrations

SIGGRAPH 2020 Emerging Technologies: Light-Field Displays: a View-Dependent Approach

SIGGRAPH 2020 Emerging Technologies: ThinVR: VR displays with wide FOV in a compact form factor

SIGGRAPH 2017 Emerging Technologies: Mid-Air Interaction with a 3D Aerial Display

SIGGRAPH 1991 Tomorrow's Realities: Ceiling Tracker

Professional Activities

Inaugural member of the IEEE VGTC Virtual Reality Academy (2022)

Served as ISMAR 2021 panels co-chair.

Served on committee that determined the "10 year impact paper" at ISMAR 2019.

Served on poster award committee for ISMAR 2017.

Participated in the IVRI Summit (May 2017). The International Virtual Reality Institute is a new VR/AR research center headed by Tom Furness.

Served as judge for Auggie awards for Augmented World Expo 2016

International Advisory Board member of the *International Journal of Virtual and Augmented Reality (IJVAR)*

IEEE Fellow (January 2016)

Paper Awards Chair for *IEEE International Symposium on Mixed and Augmented Reality* 2015.

I am a member of the team that won an Intel Labs Academy Award for the "Best Promising New Idea" (April 2014).

I started serving on the Advisory Board for NITLE (National Institute for Technology in Liberal Education) in Fall 2013.

I was a member of the Steering Committee for the *IEEE/ACM International Symposium on Mixed and Augmented Reality* from 2002-2020, and served as Chair from 2008-2012.

My original AR survey paper was selected as one of 50 influential journal articles by MIT Press. These papers were selected from over 80 MIT Press journals from 1969 to 2011, covering all academic fields.

Co-guest editor of *Computers & Graphics* special issue on "Mobile Augmented Reality" (August 2011)

Program Chair for *IEEE/ACM International Symposium on Mixed and Augmented Reality* 2002 and 2005

Program Chair for *International Symposium on Augmented Reality* 2001

Area Chair for *IEEE/ACM International Symposium on Mixed and Augmented Reality* 2004 [There were ten area chairs who decided which papers to accept] and ISMAR 2006 and 2007 [One of 12 area chairs].

Invited attendee of the 9th Annual *National Academy of Engineering Symposium on Frontiers of Engineering* (Sept. 2003). Attendance was limited to 100 young engineers (50% from industry, 50% from academia) chosen through a competitive selection process. Also invited attendee of the 2005 *Japan-America Frontiers of Engineering Symposium* (Nov. 2005)

Co-Organizer for session on Augmented Reality at the *National Academy of Engineering's 2010 EU-US Symposium on Frontiers of Engineering* (Sept. 2010). Held in Cambridge, UK. Responsible for choosing session topic, recruiting speakers and attendees, and organizing session.

Awards Chair for *IEEE/ACM International Symposium on Mixed and Augmented Reality* 2008

Instructor in *SIGGRAPH* 1995, 1997, 2001 and 2004 courses

IEEE VRAIS (95-98) program committee

IEEE Virtual Reality conference (1999-2002) program committee

VRST conference (2004-2005) program committee

First International Workshop on Mobile Geospatial Augmented Reality scientific committee (2006)

International Workshop on Augmented Reality (1998-2000) program committee

Reviewer for *IEEE ISMAR, ACM SIGGRAPH, IEEE TVCG, IEEE VR, Presence, EGVE,* and others

ACM Senior Member

Member ACM SIGGRAPH and IEEE Computer Society

Former Science Advisory Board member of the USC Integrated Media Systems Center

Former advisory board member for UC Irvine's Center for Virtual Reality

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Contract Fundraising

Pre-launch weapon detection. One DARPA STO seedling. (2008)

CT2WS [Cognitive Technology Threat Warning System]. DARPA STO. (2007)

COVER ME seedling. DARPA IXO. (2007)

UltraVis seedling and Immersive Operations panel. DARPA IXO. (2006)

Pre-launch detection of RPG's. One DARPA STO seedling. Two DARPA TTO seedlings. (2005-6)

Visualization for Insight into the Overall NAS (VisION). AFRL Rome (2004-5)

AR Vision System for Ground Controller. SBIR (NASA/Seagull), in two phases (1999-2001)

Direct Visualization of the Electronic Battlefield. DARPA ATO (1999-2000)

Geospatial Registration of Information for Dismounted Soldiers. DARPA ETO (1997-1999)

Human-Computer Symbiotes. DARPA ITO (1997-1999)

Citizenship

I am a US citizen.

COVID-19 vaccination status

I am fully vaccinated.