David Michael Krum

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Research Interests

I am a computer scientist, researcher, and educator. My areas of interest include human-computer interaction, virtual/augmented reality, and 3D interaction. My research process combines an engineering approach of designing and building technical artifacts with a scientific approach of experimentation and user evaluation. My current research examines the effects of immersive experiences on learning, as well as immersive collaboration environments for humans, virtual agents, and robots. My goal is to use immersive technologies to help humans learn, communicate, and collaborate. My prior work facilitated the development of low cost virtual reality and augmented reality displays, which inspired devices such as the Google Cardboard, Samsung Gear VR, and Oculus Rift, and revolutionized the VR/AR industry.

In my teaching, I leverage my experiences in industry, research, and academia to prepare students for a wide variety of careers in computing. I help students gain experience in team projects, both in the classroom and in the research lab, so that they are prepared to succeed in creative, collaborative workplaces. I frequently teach courses in introductory programming, 3D game design and development, virtual reality, and human centered design (interface and interaction design).

Education

Georgia Institute of Technology, Atlanta, GA — December 2004
Doctor of Philosophy, Computer Science (Minor in Psychology)
Thesis: *Wearable Computers and Spatial Cognition*
Advisors: Dr. William Ribarsky and Dr. Larry Hodges

The University of Alabama in Huntsville, Huntsville, AL — June 1998
Master of Science, Computer Science

California Institute of Technology, Pasadena, CA — June 1994
Bachelor of Science, Engineering and Applied Science

Professional Experience

Assistant Professor, Computer Science — August 2020-Present
California State University, Los Angeles
I educate students and lead research in computer science, specializing in human-computer interaction, virtual reality, and game development at the number one university in the United States for upward mobility of students. I co-direct the Institute for Interactive Arts, Research, and Technology (InART), which advances the art, practice, and research of digital media, including narrative (storytelling) and game design. I lead the Experience Lab (XP Lab) which researches techniques and technologies for virtual and augmented reality. I work to provide and expand learning and research opportunities for undergraduate and Master's students.

Associate Director for Mixed Reality Technology/Research Scientist — August 2019-July 2020
Interim Lab Director/Computer Scientist — October 2018-August 2019
Associate Lab Director/Computer Scientist — August 2008-October 2018
USC Institute for Creative Technologies, Playa Vista, CA
Provided leadership in the Mixed Reality Lab (MxR) at the Institute for Creative Technologies, a University Affiliated Research Center within the University of Southern California. Developed and executed a research vision, wrote proposals, and lead researchers, developers, and students. Research directions included techniques and technologies for immersive virtual reality experiences (head mounted displays, interaction techniques, social/mental effects of immersion). The lab's research inspired and guided the recent revolution in consumer virtual reality. Influenced products include: Google Cardboard, Samsung Gear VR, and Oculus Rift.

Senior Software Engineer/Project Manager October 2004-July 2008
Robert Bosch Research and Technology Center, Palo Alto, CA
Researcher at innovation lab of a large, multi-national corporation. Responsibilities included identifying, developing, and transferring new technologies for a variety of corporate business units. Made significant contributions to the corporate research strategies for user interaction, 3D technologies, and computer graphics/imaging. Developed 3D visualizations that integrated live video surveillance and other sensors for the security technologies business unit. Also directed a related university collaboration with Virginia Tech. Led research into novel user interfaces for driver information and automobile multimedia systems. Supervised research projects conducted by summer interns.

Technology Consultant and Co-Founder September 2003-September 2005
GeoTravel Knowledge, Denver, CO
Provided technical consulting to a media start-up firm. Designed and developed software for a GPS location based tourist information guide.

Graduate Research Assistant September 1998-December 2003
Georgia Institute of Technology, College of Computing, Atlanta, GA
Advisors: Dr. William Ribarsky and Dr. Larry Hodges
Researched two-handed and multi-modal navigation techniques for 3D visualizations, two-handed interactions for a workbench virtual reality display, and developed and evaluated wearable computer based spatial cognition aids. Supervised graduate and undergraduate students in several virtual reality and wearable computer research projects.

Software Engineer October 1994-June 1998
Motorola Transmission Products Division, Huntsville, AL
Developed Microsoft Windows software for upgrade, security, configuration, and installation of modems and ISDN terminal adapters. Participated in efforts leading to SEI CMM Level 2 and ISO 9000 certifications. Developed a patented ISDN configuration process that improved the customer experience and resulted in the BitSURFR Pro ISDN modem receiving a PC Magazine Best Product Award in 1996.

Summer Undergraduate Research Fellowship Summer 1993
California Institute of Technology, High Energy Physics Department
Advisor: Dr. Maarten Schmidt
Developed initial requirements and design for the software and electronics of the GAMCIT space shuttle experiment. This payload combined GPS, gamma ray burst detector, and camera to correlate gamma ray bursts with visible light phenomena. Payload was orbited by space shuttle Endeavour in May 1996.

EDUCATIONAL PERFORMANCE

Assistant Professor/Instructor September 2020 to Present
California State University, Los Angeles, Computer Science Department, Los Angeles, CA

CS 4540, Topics in Adv. Computer Science: *Virtual Reality and Immersive Worlds* Spring 2023, Spring 2024
Developed and introduced a new upper division course on the science and engineering of virtual reality and other immersive experiences. Acquired 60 Meta Quest 2 virtual reality headsets enabling 1:1 student access to VR displays (through university funding and a successful educational grant application awarded by Meta and Unity). Course covers immersive technologies, human factors (perception, cognition, and movement), and virtual reality software development using the Unity Game Engine. Course enrollment is 50 undergraduate and graduate students.

CS 4875, *Human Centered Computing* Spring 2021, 2022, Fall 2024
Previously listed as CS 4540, Topics in Adv. Computer Science: *Human Centered Computing*.
Developed and introduced a new upper division course on human centered computing which introduces interaction design principles and methods for evaluating user interfaces and user experiences. Students are introduced to models of human cognition, emotion, and behavior. Team projects provided opportunities for students to follow a human centered engineering approach from persona development through prototyping and evaluation.

ENGR 1540, *Human Centered Design and Engineering for Impact* Spring 2024
Helped to develop and teach a new lower division course on user centered design for undergraduate engineering students (CS, EE, ME, CE). This course immersed students in an cross-disciplinary approach to solving community problems by teaching how to engage with users, develop requirements, and design and iterate and evaluate prototypes. The

theme for team projects in the initial course centered on designing solutions for problems encountered by pet owners. This course serves as an introduction for students participating in the IMPACT program at the College of ECST at Cal State LA. IMPACT engages our students with making positive impacts in their communities through engineering and service.

CS 7010, ***Intro to Computational Thinking and Programming*** Summer 2024

I co-developed and helped teach a new introductory computer science course for in-service teachers. This course is part of the Cal State LA CSSA program, which provides current teachers with the skills and knowledge to also teach computer science at the K-12 levels. This program also satisfies the training needed by teachers to earn a Computer Science Supplementary Authorization. The CSSA program helps to address the limited number of CS teachers in our state.

CS 2011, ***Introduction to Programming I*** Spring 2023, Fall 2023

Instructor for the introductory programming course in Java. The course introduces student to designing, implementing, debugging, and documenting programs. The course also provides an introduction to basic algorithms and basis software engineering methods. Created and piloted new assignments to introduce a new Socially Responsible Computing curriculum, see EF.17.

CS 4555, ***Introduction to 3D Game Programming*** Fall 2020, 2021, 2022, 2023, 2024

Introduced game design principles, history and organization of the game industry, and user testing methods to the existing game development course covering software development with the Unity game engine. Course enrollment included graduate and upper division students (62, 30, 61, 62 students enrolled over 4 semesters). Students teams (3-4 students) worked on projects from concept through design and implementation of a working prototype. Taught with remote learning and remote team collaboration due to COVID-19 pandemic in the first two semesters, followed by in-person learning.

Graduate Teaching Assistant January-December 2003

Georgia Institute of Technology, College of Computing, Atlanta, GA

CS 4750, ***Human-Computer Interface Design and Evaluation*** Spring, Summer, Fall 2003

Instructors: Dr. Elaine Huang, Dr. Chris Shaw, Dr. James Foley

Teaching assistant for three semesters of an upper level undergraduate Human-Computer Interaction course. Topics included user and task modeling, human centered design principles, and evaluation methods. Developed and graded assignments. Also mentored and graded semester long team projects.

Computer Science Instructor May-August 2002

Georgia Institute of Technology, College of Computing, Atlanta, GA

CS 4451, ***Computer Graphics*** Summer 2002

Instructor for a graduate/senior level OpenGL computer graphics course. Enrollment of 41 undergraduates, Master's, and PhD students. Course served as part of the core requirements in graphics for PhD students.

Undergraduate Teaching Assistant September-December 1992 & 1993

California Institute of Technology, Computer Science Department, Pasadena, CA

CS 1, ***Introduction to Computation*** Fall 1992, Fall 1993

Instructor: Dr. Stephen Taylor

Teaching assistant for two terms of an introductory C programming course.

Undergraduate Senior Capstone Mentoring

- VIPER Rocks! NASA Citizen Science Website (NASA JPL): Kevin Andrade, Diana Arteaga-Andrade, Santiago Bautista, Michael Gibson, Cristian Gomez, Nida Sheikh, Zainab Sulaiman, Diane Tabilas, Angy Xajil Ujpan, Tammy Xaypraseuth, 2023-2024
- SUAS Flight Path Visualization (Army Research Lab): Alex Alcazar, Franciso Brito, Helen Dam, Alex Gaeta, Alberto Gonzalez, Sergio Maradiaga Olivera, Thad Owens, Mychal Salgado, Kevin Tang, Sergio Valadez Polanco, 2023-2024
- Virtual Reality Training Simulation (Southern California Edison): Han Cao, Martin Castorena, Cameron Cheng, Manuel Guillen Vargas, Jaiden Holcomb, 2022-2023
- Trek Virtual Reality (VR) Room Project (NASA JPL): Lucca Andrade Guedes Galvao Coutinho, Fabio Carrasco, Enrique Guardado, Ruben Heredia, Ari Jasko, Bryan Lopez, Ly Jacky Nhiayi, Ayush Singh, Rizwan Vazifdar, Justin Vuong, 2022-2023
- Human Perceptual Models Project (Army Research Lab): Jonathan Aguirre, Lloyd Castro, Jean Espinosa, Peter Han, George Hernandez, Hugo Izquierdo, Raymond Martinez, Bruck Negash, Jesus Perez Arias, 2022-2023

- Operationalize Networked Collaboration Features for Moon Trek (NASA JPL): Sean Chung, Aldo Gil, Tommy Lay, Allen Marquez, Tam Nguyen, Alex Sahakian, Andy Tsan, Srivats Venkataraman, Jian Wu, Anna Yesayan, 2021-2022
- Immersive Storytelling with Engaging Physical Actions (InART): Joseph Chong, Jimmy Hernandez, Edwin Hernandez, Jaquan Jones, Alberto Landeros, Tony Lee, Jennelle Maximo, Eduardo Meza, Dean Nguyen, Anthony Viramontes, 2021-2022
- Collaborative Visualization for Solar System Treks (NASA JPL): Abdullah Alshebly, Stanley Do, Jose Garcia, Zipeng Guo, Johnny Lee, La France Montague, Miguel Sanchez, Christopher Smallwood, Odasys Soberanes, David Tang, 2020-2021
- InART VR Project (InART): Noah Castro, Kevin Diaz-Lopez, Jessy Francisco, Steve Galvan, David Hermosillo, Kiet Hoang, Taha Kamran, Zudong Li, Daniel Ramirez Torres, 2020-2021

Undergraduate Research Mentoring

- Computing Alliance for Hispanic Serving Institutions, Local Research Experiences for Undergraduates (CAHSI LREU): Daniel Ontiveros, 2023-2024
- Student Researcher: Daniel Ramirez, 2021-2024
- Computing Alliance for Hispanic Serving Institutions, Local Research Experiences for Undergraduates (CAHSI LREU): Bryan Perez, Nathan Campos, 2022-2023
- Student Researcher (Army Research Lab-West): Nicholas Sandoval, Summer 2021
- NSF Research Experiences for Undergraduates (NSF REU): Katherine Hsiao, Robert Silverberg, 2019
- Directed Research: Anurag Syal, 2019
- Directed Research: Chaitanya Gupte, 2018-2019
- NSF REU: Jake Chanenson, Peter Cowal, Madeleine Weaver, Danielle Oltman, Faizon Williams, 2018
- Directed Research: Will Durkee, 2018
- Directed Research: Cindy Clarissa, Daniel Kawalsky, 2017
- NSF REU: Tram-Anh Nguyen, Alice Tan, 2017
- Visiting Research Assistant: Stephanie Schulze, 2017
- NSF REU/Watson Fellow: Hilliary Frank, 2017
- NSF REU: Sophia Sun, Anna Chung, and Elitanya De La Cruz, 2016
- NSF REU: Alice Zhou, 2015
- Summer Undergraduate Research Fellow: Ayaana Sikora, 2015
- Directed Research: Saurabh Hukerikar, 2009

Graduate Research Mentoring

- Master's Thesis and Student Researcher (VIPER Rocks!): Jerome Pineda, 2023-Present
- Master's Thesis: Shannon Leigh, 2022-2023
- Master's Thesis: Aliannea Sherman, 2020-2023 (Graduated)
- Master's Thesis: Zipeng Guo, 2022-2023 (Graduated)
- Master's Thesis: Pasindu Siriwardena, 2021-2022 (Graduated)
- Directed Research: Mari Kyle, 2016
- Visiting Research Assistant: Lauren Dukes, 2013
- Visiting Research Assistant: Anamary Leal, 2011
- Bosch RTC Intern: Daniela Buhr, Regis Kooper, 2007
- Bosch RTC Intern: Shanshan Zhang, 2006-2007
- Bosch RTC Intern: Tao Ni, Yi Wang, 2006

Dissertation/Thesis/Project Committee

- Thesis Advising Committee Member for Hazina Cain-Houston, Economics MS Candidate, Cal State LA, 2021
- Thesis Project Committee Member for Ala' Diab, Interactive Media MFA Candidate, University of Southern California, 2010
- Dissertation Committee External Member for Yi Wang, Computer Science PhD Candidate, Virginia Tech, 2010

Post-Doctoral Mentoring

- Dr. J. Adam Jones, 2012-2014 (Assistant Professor, Computer Science, Mississippi State University)
- Dr. Tyler Ard, 2015 (Assistant Professor, USC Neuroimaging and Informatics Institute)

Visiting Scholars Hosted

- Dr. Jusub Kim, Sogang University, 2018-2019
- Dr. Pablo Figueroa, Universidad de los Andes, Colombia, 2016

PROFESSIONAL ACHIEVEMENT

External Funding

EF.19 National Science Foundation, Collaborative Research: CCRI: New: OpenHMI: Community-Designed Infrastructure for Human-Machine Interaction Research (2346533) **In submission**. Submitted as a collaborative, multi-university grant. David M. Krum (PI) and Elaine Kang (Co-PI) — 2023-2025, $200,000 (Total Request: $2 Million)

EF.18 NASA, VIPER Rocks! (22-CSSFP22-0006) Selected for award by NNH22ZDA001N-CSSFP:F.9 Citizen Science Seed Funding Program David M. Krum (PI) and Ariel Deutsch (Science PI) — 2023-2024, $79,989

EF.17 National Science Foundation, Collaborative Research: BPC-A: Socially Responsible Computing: Promoting Latinx student retention via community engagement in early CS courses (2216694) Awarded as a collaborative, multi-university grant. Elaine Kang (PI) and David M. Krum (Co-PI) — 2022-2025, $203,828 (Total Funding: $1.8M)

EF.16 National Science Foundation, NRI: FND: Communicate, Share, Adapt: A Mixed Reality Framework for Facilitating Robot Integration and Customization (1925083) Maja Mataric (PI) and David M. Krum (Co-PI) — 2019-2022, $749,250

EF.15 United States Air Force Academy, DisCoVR: Distributed Collaboration in Virtual Reality David M. Krum (PI) and Sinhwa Kang (Co-PI) — 2019-2020, $500,000

EF.14 DARPA, Urban Reconnaissance through Supervised Autonomy (URSA) David M. Krum (PI) — 2019-2020, $1,170,259

EF.13 Army Research Office, Tracking Sense-Making and Decision-Making in Immersive Training David M. Krum (PI) and Sinhwa Kang (Co-PI) — 2019-2020, $1.0 Million

EF.12 Army Research Office, Mixed, Virtual, and Augmented Reality Research and Development Project Leaders: Todd Richmond, Evan Suma Rosenberg, and David M. Krum — 2018-2019, $574,000

EF.11 Army Research Office, Cortically Coupled Computing in Augmented Reality David M. Krum (PI) and Sinhwa Kang (Co-PI) — 2017-2019, $1.1 Million

EF.10 Army Research Office, Team Assessment and Learner Knowledge Observational Network (TALK-ON) David M. Krum (PI) — 2016, $216,000

EF.9 Army Research Office, Omni-Directional Treadmill Unity Upgrade (ODT) David M. Krum (PI) — 2015, $115,971

EF.8 Army Research Office, Motor Adaptation and Learning in Variable Fidelity Virtual Environments David M. Krum (PI) and Sinhwa Kang (Co-PI) — 2015-2016, $299,919

EF.7 Army Research Office, Adapting to Social Interactions with Virtual Humans (ASIV), David M. Krum(Co-PI), and Sinhwa Kang(Co-PI) — 2015-2016, $299,924

EF.6 Army Research Office, Mixed Reality Research and Development Project Leaders: Todd Richmond, David M. Krum, and Evan Suma — 2014-2017, $4.6 Million

EF.5 Seoul Institute of the Arts, Immersive Narrative in Game Design Project Leaders: Sinhwa Kang and David M. Krum — 2014-2015, $30,063

EF.4 Office of Naval Research, Mapping the Field of View — 2013-2015
Mark Bolas (PI), Adam Jones, Evan Suma (Co-Investigator), and David M. Krum — $506,141

EF.3 Defense Advanced Research Projects Agency, To the Tablets: Applying Immersive — 2012-2014
Body-Based Interactions to Data Analysis — $1.68 Million
Project Leaders: Mark Bolas and David M. Krum

EF.2 Army Research Office, Mixed Reality Research and Development — 2012-2014
Project Leaders: Mark Bolas, David M. Krum, and Evan Suma — $3.1 Million

EF.1 Army Research Office, Mixed Reality Research and Development — 2010-2011
Project Leaders: Mark Bolas, David M. Krum, and Evan Suma — $1.3 Million

Internal Funding

IF.2 ICT Seedling, Proxemics in Virtual Training — 2016
Sinhwa Kang (PI) and David M. Krum (Co-PI) — $99,604

IF.1 ICT Seedling, Mobile Simcoach: Virtual Coaches over Mobile Video — 2013-2014
Sinhwa Kang (PI) and David M. Krum (Co-PI) — $90,000

PUBLICATIONS AND PATENTS

Journal Papers (Peer Reviewed) and Book Chapters

J.17 S. Mishra, M. Corro-Flores, D. Krum, and N. Forouzesh *Molecular Docking Improved with Human Spatial Perception Using Virtual Reality.* Virtual, IEEE Transactions on Visualization and Computer Graphics, IEEE, vol. 30, no. 5, May 2024, pp. 2269-2275, doi: 10.1109/TVCG.2024.3372128.

J.16 C. Descheneaux, L. Reinerman-Jones, J. Moss, D.M. Krum, and I. Hudson. *Negative Effects Associated with HMDs in Augmented and Virtual Reality.* Virtual, Augmented and Mixed Reality Design and Interaction, Springer International Publishing, July 10, 2020, pp. 410-428.

J.15 J.M. Juliano, R.P. Spicer, A. Vourvopoulos, S. Lefebvre, K. Jann, T. Ard, E. Santarnecchi, D.M. Krum, S.-L. Liew. *Embodiment Is Related to Better Performance on a Brain-Computer Interface in Immersive Virtual Reality: A Pilot Study.* Sensors February 22, 2020, 20(4), 1204.

J.14 J.A. Jones, J.E. Hopper, M.T. Bolas, and D.M. Krum. *Orientation Perception in Real and Virtual Environments.* IEEE Transactions on Visualization and Computer Graphics (TVCG) Special Issue on IEEE Virtual Reality and 3D User Interfaces (IEEE VR), Vol. 25, No. 5, February 2019, pp. 2050-2060.

J.13 Y. Gil, S. Pierce, H. Babaie, A. Banerjee, K. Borne, G. Bust, M. Cheatham, I. Ebert-Uphoff, C. Gomes, M. Hill, J. Horel, L. Hsu, J. Kinter, C. Knoblock, D. Krum, V. Kumar, P. Lermusiaux, Y. Liu, C. North, V. Pankratius, S. Peters, B. Plale, A. Pope, S. Ravela, J. Restrepo, A. Ridley, H. Samet, S. Shekhar, K. Skinner, P. Smyth, B. Tikoff, L. Yarmey, and J. Zhang. *Intelligent Systems for Geosciences: An Essential Research Agenda.* Communications of the ACM, Vol. 62, No. 1, December 2018, pp. 76-84.

J.12 S. Kang, D.M. Krum, P. Khooshabeh, T. Phan, C.Y. Chang, O. Amir, and R. Lin. *Social Influence of Humor in Virtual Human Counselor's Self-Disclosure.* Computer Animation and Virtual Worlds, Vol. 28, No. 3-4, April 19, 2017, pp. e1763.

J.11 J.A. Jones, D.M. Krum, and M.T. Bolas. *Vertical Field-of-View Extension and Walking Characteristics in Head-Worn Virtual Environments.* ACM Transactions on Applied Perception, Vol. 14, No. 2, January 2017, Article 9, 17 pages.

J.10 S. Kang, D. Krum, T. Phan, and M. Bolas. *Users' Perception of a Virtual Human over Mobile Video Chat Interactions.* Human-Computer Interaction: Novel User Experiences, Vol. 9733, June 2016, Springer, pp. 107-118.

J.9 L.J. Mariano, J.C. Poore, D.M. Krum, and J.L. Schwartz, W.D. Coskren, and E.M. Jones. *Modeling Strategic Use of Human Computer Interfaces with Novel Hidden Markov Models.* Frontiers in Psychology, July 3, 2015, pp. 319-331.

J.8 E.A. Suma, D. Krum, and M. Bolas. *Redirected Walking in Mixed Reality Training Applications.* Human Walking in Virtual Environments: Perception, Technology, and Applications, 2013, Springer, pp. 319-331.

J.7 E.A. Suma, D.M. Krum, B. Lange, S. Koenig, A. Rizzo and M. Bolas. *Adapting User Interfaces for Gestural Interaction with the Flexible Action and Articulated Skeleton Toolkit.* Computers and Graphics, Vol. 37, No. 3, May 2013, pp. 193-201.

J.6 E.A. Suma, Z. Lipps, S. Finkelstein, D.M. Krum, and M. Bolas. *Impossible Spaces: Maximizing Natural Walking in Virtual Environments with Self-Overlapping Architecture.* IEEE Transactions on Visualization and Computer Graphics, Vol. 18, No. 4, April 2012, pp. 555-564.
(Best Paper Honorable Mention, IEEE VR 2012)

J.5 L.K. Lu, J.M. Ko, J. Lee, D.M. Krum, L. Lyn Price, D. Finn, D. Lee, and G.S. Rogers. *A Random, Prospective Trail Evaluating Surgeon Preference in Selection of Absorbable Suture Material.* Journal of Drugs in Dermatology, Vol. 11, No. 2, February 2012, pp. 196-201.

J.4 D.M. Krum, E.A. Suma, and M. Bolas. *Augmented Reality using Personal Projection and Retroreflection.* Personal and Ubiquitous Computing, Vol. 16, No. 1, January 2012, pp. 17-26.

J.3 Y. Wang, D. Bowman, D.M. Krum, E. Coelho, T. Smith-Jackson, D. Bailey, S. Peck, S. Anand, T. Kennedy, and Y. Abdrazakov. *Effects of Video Placement and Spatial Context Presentation on Path Reconstruction Tasks with Contextualized Videos.* IEEE Transactions on Visualization and Computer Graphics, Vol. 14, No. 6, November/December 2008, pp. 1755-1762.

J.2 Y. Wang, D.M. Krum, E.M. Coelho, D.A. Bowman. *Contextualized Videos: Combining Videos with Environment Models to Support Situational Understanding.* IEEE Transactions on Visualization and Computer Graphics, Vol. 12, No. 6, November/December 2007, pp. 1568-1575.

J.1 B. Leibe, T. Starner, W. Ribarsky, Z. Wartell, D. Krum, J. Weeks, B. Singletary, L. Hodges. *Towards Spontaneous Interaction with the Perceptive Workbench.* IEEE Computer Graphics and Applications, Vol. 20, No. 6, November/December 2000, pp. 54-65.

Conference Full Papers (Peer Reviewed)

C.16 S. Mishra, M. Corro-Flores, N. Forouzesh, and D.M. Krum. *Interactive Molecular Docking Improved With Human Spatial Perception Using Virtual Reality.* IEEE Virtual Reality Conference 2023, **in submission**.

C.15 P. Chaffey, R. Artstein, K. Georgila, K.A. Pollard, S.N. Gilani, D.M. Krum, D. Nelson, K. Huynh, A. Gainer, S.H. Alavi, R. Yahata, A. Leuski, V. Yanov, and D. Traum. *Human Swarm Interaction using Plays, Audibles, and a Virtual Spokesperson.* Proc. SPIE 11413, Artificial Intelligence and Machine Learning for Multi-Domain Operations Applications, 114130V, April 22, 2020.

C.14 P. Chaffey, R. Artstein, K. Georgila, K.A. Pollard, S.N. Gilani, D.M. Krum, D. Nelson, K. Huynh, A. Gainer, S.H. Alavi, R. Yahata, and D. Traum. *Developing a Virtual Reality Wildfire Simulation to Analyze Human Communication and Interaction with a Robotic Swarm During Emergencies.* Language and Technology Conference 2019, May 17-19, 2019, Poznań, Poland.

C.13 W. Panlener, D.M. Krum, and J.A. Jones. *Effects of Horizontal Field of View Extension on Spatial Judgments in Virtual Reality.* IEEE SoutheastCon 2019, April 11-14, 2019, Huntsville, AL. IEEE Press.

C.12 S. Kang, D. Krum, P. Khooshabeh, T. Phan, and K. Chang. *Socio-Cultural Effects of Virtual Counseling Interviewers as Mediated by Smartphone Video Conferencing.* International Conference on Computer Animation and Social Agents (CASA), May 21-23, 2018, Beijing, China. ACM Press, pp. 17-22.

C.11 D. Krum, S. Kang, and T. Phan. *Influences on the Elicitation of Interpersonal Space with Virtual Humans.* IEEE Virtual Reality, March 18-22, 2018, Reutlingen, Germany. IEEE Press, pp. 223-229.

C.10 J. Thomas, M. Azmandian, S. Grunwald, Donna Le, D. Krum, S. Kang, and E. Suma Rosenberg. *Effects of Personalized Avatar Texture Fidelity on Identity Recognition in Virtual Reality.* ICAT-EGVE 2017, November 22-24, 2017, Adelaide, Australia. The Eurographics Association, pp. 97-100.

C.9 D.M. Krum, S. Kang, T. Phan, L.C. Dukes, and M. Bolas. *Social Impact of Enhanced Gaze Presentation Using Head Mounted Projection.* Human-Computer Interaction International Conference, July 9-14, 2017, Vancouver, Canada. Springer International Publishing, pp. 61-76.

C.8 S. Kang, D. Krum, T. Phan, and M. Bolas. *"Hi, It's Me Again!": Virtual Coaches over Mobile Video.* International Conference on Human-Agent Interaction (HAI), October 21-24, 2015, Daegu, Kyungpook, South Korea, ACM Press, pp. 183-186.

C.7 J.A. Jones, L.C. Dukes, D.M. Krum, M.T. Bolas, and L.F. Hodges. *Corrections of Geometric Distortions and the Impact of Eye Position in Virtual Reality Displays.* International Conference on Collaboration Technologies and Systems (CTS), June 1-5, 2015, Atlanta, Georgia, pp. 77-83.

C.6 E.A. Suma, S. Clark, S. Finklestein, Z. Wartell, D. Krum, and M. Bolas. *Leveraging Change Blindness for Redirection in Virtual Environments.* IEEE Virtual Reality Conference, March 19-23, 2011, Singapore: IEEE Press, pp. 159-166.

C.5 B. MacIntyre, J.D. Bolter, J. Vaughn, B. Hannigan, M. Gandy, E. Moreno, M. Haas, S. Kang, D. Krum, S. Voida. *Three Angry Men: An Augmented-Reality Experiment in Point-of-View Drama.* First International Conference on Technologies for Interactive Digital Storytelling and Entertainment (TIDSE), March 24-26, 2003, Darmstadt, Germany.

C.4 D.M. Krum, O. Omoteso, W. Ribarsky, T. Starner, L.F. Hodges. *Evaluation of a Multimodal Interface for 3D Terrain Visualization.* IEEE Visualization, October 27-November 1, 2002, Boston, MA: IEEE Computer Society, pp. 411-418.

C.3 D.M. Krum, O. Omoteso, W. Ribarsky, T. Starner, L.F. Hodges. *Speech and Gesture Control of a Whole Earth 3D Visualization Environment.* VisSym '02, Joint Eurographics - IEEE TCVG Symposium on Visualization, May 27-29, 2002, Barcelona, Spain: IEEE Computer Society, pp. 195-200.
(Awarded SAIC Georgia Tech Student Paper Award)

C.2 D.M. Krum, W. Ribarsky, C.D. Shaw, L. Hodges, N. Faust. *Situational Visualization.* ACM Symposium on Virtual Reality Software and Technology, November 15-17, 2001, Banff, Alberta, Canada: ACM Press, pp. 143-150.

C.1 B. Leibe, T. Starner, W. Ribarsky, Z. Wartell, D. Krum, B. Singletary, L. Hodges. *The Perceptive Workbench: Towards Spontaneous Interaction with the Perceptive Workbench.* Proceedings of the IEEE Virtual Reality 2000 Conference, March 18-22, 2000, New Brunswick, New Jersey: IEEE Computer Society, pp. 13-20.
(Awarded Best Paper Award, IEEE VR 2000)

Conference Short Papers (Peer Reviewed)

c.7 D. Krum, S. Kang, and M. Bolas. *Virtual Coaches over Mobile Video.* International Conference on Computer Animation and Social Agents (CASA), May 26-28, 2014, Houston, Texas.

c.6 D.M. Krum, E.A. Suma, and M. Bolas. *Spatial Misregistration of Virtual Human Audio: Implications of the Precedence Effect.* International Conference on Intelligent Virtual Agents (IVA), September 12-14, 2012, Santa Cruz, California: Springer-Verlag, pp. 139-145.

c.5 E.A. Suma, G. Bruder, F. Steinicke, D.M. Krum, and M. Bolas. *A Taxonomy for Deploying Redirection Techniques in Immersive Virtual Environments.* IEEE Virtual Reality Conference 2012, Costa Mesa, California: IEEE Press, pp. 43-46.

c.4 N. Burba, M. Bolas, D.M. Krum, and E.A. Suma. *Unobtrusive Measurement of Subtle Nonverbal Behaviors with the Microsoft Kinect.* IEEE Virtual Reality 2012, Workshop on Ambient Information Technologies, Costa Mesa, California: IEEE Press, pp. 10-13.

c.3 E.A. Suma, D.M. Krum, S. Finklestein, and M. Bolas. *Effects of Redirection on Spatial Orientation in Real and Virtual Environments.* IEEE Symposium on 3D User Interfaces, 2011, Singapore: IEEE Press, pp. 35-38.
(Awarded Best Technote Award, 3DUI 2011)

c.2 D.M. Krum, R. Melby, W. Ribarsky, L. Hodges. *Isometric Pointer Interfaces for Wearable 3D Visualization.* Extended Abstracts of the CHI Conference on Human Factors in Computing Systems, April 5-10, 2003, Ft. Lauderdale, FL: ACM Press, pp. 774-775.

c.1 A.F. Seay, D. Krum, W. Ribarsky, L. Hodges. *Multimodal Interaction Techniques for the Virtual Workbench.* Extended Abstracts of the ACM CHI Conference on Human Factors in Computing Systems, May 15-20, 1999, Pittsburgh, Pennsylvania: ACM SIGCHI, pp. 282-283.

Posters, Sessions, and Panels

p.20 S. Kang, J. Chanenson, P. Cowal, M. Weaver, P. Ghate, D.M. Krum. *Advancing Ethical Decision Making in Virtual Reality.* IEEE Virtual Reality, March 23-27, 2019, Osaka, Japan. pp. 1008-1009.

p.19 J. Crawford, G. Glesener, D.M. Krum, C. Dietrich, and K. Morishita. *Distinguished Panel on Artificial Intelligence and Virtual Reality.* IEEE International Conference on Semantic Computing, January 31-February 2, 2018, Laguna Hills, California: IEEE Press.

p.18 D.M. Krum, S. Liew, T. Ard, M.V. Sanchez-Vives, and M. Slater. *Virtual Reality and Neuroscience.* IEEE Virtual Reality 2017, Manhattan Beach, California: IEEE Press.

p.17 D.M. Krum, T. Phan, and S. Kang. *Motor Adaptation in Response to Scaling and Diminished Feedback in Virtual Reality.* IEEE Virtual Reality 2017, Manhattan Beach, California: IEEE Press, pp 233-234.
(Awarded Best Poster Award, IEEE VR 2017)

p.16 P. Khooshabeh, I. Choromanski, C. Neubauer, D.M. Krum, R, Spicer, and J. Campbell. *Mixed Reality Training for Tank Platoon Leader Communication Skills.* IEEE Virtual Reality 2017, Manhattan Beach, California: IEEE Press, pp. 333-334.

p.15 R. Spicer, J. Anglin, D.M. Krum, and S. Liew. *A Low-Cost, Virtual Reality Brain-Computer Interface for Severe Stroke Upper Limb Motor Recovery.* IEEE Virtual Reality 2017, Manhattan Beach, California: IEEE Press, pp. 385-386.

p.14 D.M. Krum, S. Kang, T. Phan, L.C. Dukes, and M. Bolas. *Head Mounted Projection for Enhanced Gaze in Social Interactions.* IEEE Virtual Reality 2016, Greenville, South Carolina: IEEE Press, pp. 209-210.

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p.12 D.M. Krum, T. Phan, L.C. Dukes, P. Wang, and M. Bolas. *Tablet-Based Interaction Panels for Immersive Environments.* IEEE Virtual Reality 2014, Minneapolis, Minnesota: IEEE Press, pp. 91-92.

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p.10 J.A. Jones, E.A. Suma, D.M. Krum, and M. Bolas. *Comparability of Narrow and Wide Field-of-View Head-Mounted Displays for Medium-Field Distance Judgements.* ACM Symposium on Applied Perception, August 3-4, 2012, Los Angeles, California, ACM Press, pp. 119.

p.9 D.M. Krum, E.A. Suma, and M. Bolas. *Spatial Misregistration of Virtual Human Audio: Implications of the Precedence Effect.* IEEE Symposium on 3D User Interfaces, 2012, Costa Mesa, California: IEEE Press, pp. 147-148.

p.8 P. Hoberman, D.M. Krum, E.A. Suma, and M. Bolas. *Immersive Training Games for Smartphone-based Head Mounted Displays.* IEEE Virtual Reality 2012, Costa Mesa, California: IEEE Press, pp. 151-152.

p.7 E.A. Suma, D.M. Krum, and M. Bolas. *Sharing Space in Mixed and Virtual Reality Environments Using a Low Cost Depth Sensor.* IEEE International Symposium on VR Innovation, 2011, Singapore: IEEE Press, pp. 349-350.

p.6 E.A. Suma, B. Lange, A.S. Rizzo, D.M. Krum, and M. Bolas. *FAAST: The Flexible Action and Articulated Skeleton Toolkit.* IEEE Virtual Reality 2011, Singapore: IEEE Press, pp. 247-248.

p.5 J.L. Olson, D.M. Krum, E.A. Suma, and M. Bolas. *A Design for a Smartphone-based Head Mounted Display.* IEEE Virtual Reality 2011, Singapore: IEEE Press, pp. 233-234.

p.4 R. Sadek, D.M. Krum, and M. Bolas. *Simulating Hearing Loss in Virtual Training.* IEEE Virtual Reality 2010, March 20-24, Waltham, MA: IEEE Press, pp. 299-300.

p.3 D.M. Krum, J. Faenger, B. Lathrop, J. Sison, and A. Lien. Special Interest Group Session: *All Roads Lead to CHI: Interaction in the Automobile.* Extended Abstracts of the CHI Conference on Human Factors in Computing Systems, April 5-10, 2008, Florence, Italy: ACM Press, pp. 2387-2390.

p.2 D.M. Krum (Panel Moderator), D. Manstetten, C. Nass, K.V. Prasad, R. Sicconi. Panel: *Taking CHI for a Drive: Interaction in the Car.* Extended Abstracts of the CHI Conference on Human Factors in Computing Systems, April 28-May 3, 2007, San Jose, CA: ACM Press, pp. 1917-1920.

p.1 A.F. Seay, D.M. Krum, L. Hodges, W. Ribarsky. *Simulator Sickness and Presence in a High FOV Virtual Environment.* Proceedings of the IEEE Virtual Reality 2001 Conference, March 13-17, 2001, Yokohama, Japan: IEEE Computer Society, pp. 299-300.

Workshop Papers and Workshop Posters

W.8 M.S. Dennison and D.M. Krum. *Unifying Research to Address Motion Sickness.* IEEE Virtual Reality 2019 Workshop on Immersive Sickness Prevention, March 23, 2019, Osaka, Japan, pp. 1858-1859.

W.7 T. Phan, D.M. Krum, and Mark Bolas. *ShodanVR: Immersive Visualization of Text Records from the Shodan Database.* IEEE Virtual Reality 2016 Workshop on Immersive Analytics, March 20, 2016, Greenville, South Carolina.

W.6 T. Phan, D.M. Krum, and Mark Bolas. *FAAST-R: Defining a Core Mechanic for Designing Gestural Interfaces.* ACM CHI Workshop: The 3rd Dimension of CHI: Touching and Designing 3D User Inetrfaces, May 5, 2012, Austin, Texas, pp. 35-42.

W.5 M. Bolas and D.M. Krum. *Augmented Reality Applications and User Interfaces Using Head-Coupled Near-Axis Personal Projectors with Novel Retroreflective Props and Surfaces.* Pervasive 2010 Ubiprojection, May 17, 2010, Helsinki, Finland.

W.4 D.M. Krum and M. Bolas. *The Isolated Practitioner.* CHI 2010 Workshop on Researcher-Practitioner Interaction, April 11, 2010, Atlanta, GA.

W.3 D.M. Krum, D. Piepol, M. Bolas. *Sharing and Stretching Space with Full Body Tracking.* CHI 2009 Workshop on Whole Body Interaction, April 5, 2009, Boston, MA.

W.2 D.M. Krum, E.M. Coelho, J. Faenger, Y. Meng. *Supporting Interaction as a Secondary Task in Geo-Spatial Applications.* CHI 2007 Workshop on Mobile Spatial Interaction, April 28, 2007, San Jose, CA.

W.1 D.M. Krum. *Challenges in Building a Whole Earth 3D Information Space.* The Second Young Investigator's Forum in Virtual Reality, February 12-13, 2003, Phoenix Park, Kangwon Province, South Korea.

Research Demonstrations and Other Publications

O.7 T. Ard, D.M. Krum, T. Phan, D. Duncan, R. Essex, M. Bolas, and A. Toga. *NIVR: Neuro Imaging in Virtual Reality.* IEEE Virtual Reality 2017, Manhattan Beach, California: IEEE Press, pp. 465-466.

O.6 D.M. Krum, T. Phan, L.C. Dukes, P. Wang, and M. Bolas. *A Demonstration of Tablet-based Interaction Panels for Immersive Environments.* IEEE Virtual Reality 2014, Minneapolis, Minnesota: IEEE Press, pp. 175-176.

O.5 E.A. Suma, D.M. Krum, T. Phan, and M. Bolas. *Rapid Generation of Personalized Avatars.* IEEE Virtual Reality 2013, Orlando, Florida: IEEE Press, pp. 185.

O.4 M. Bolas, J. Iliff, P. Hoberman, N. Burba, T. Phan, I. McDowall, P. Luckey, and D.M. Krum. *Open Virtual Reality.* IEEE Virtual Reality 2013, Orlando, Florida: IEEE Press, pp. 183-184.

O.3 D.M. Krum, E.A. Suma, and M. Bolas. *Virtual Reality to Go: A USC ICT Mixed Reality Lab Demonstration.* IEEE Virtual Reality 2012, Costa Mesa, California: IEEE Press, pp. 179-180.
(Awarded Best Demo Award, IEEE VR 2012)

O.2 D.M. Krum, R. Sadek, L. Kohli, L. Olson, M. Bolas. *Experiments in Mixed Reality.* SPIE, Vol. 7525, 75250F, January 21, 2010, San Jose, CA.

O.1 B.J. McCall, J.M. Grunsfeld, S.D. Sobajic, C.L. Chang, D.M. Krum, A. Ratner, J.E. Trittschuh. *The GAMCIT Gamma-Ray Burst Detector.* Proceedings of the 1993 NASA Shuttle Small Payload Symposium, NASA CP-3233, pp. 47-56.

Invited Talks

IT.11 D.M. Krum, *Creating a Human Centered Metaverse*, IEEE Vision, Innovation, and Challenges Summit, San Diego, California, May 6, 2022.

IT.10 D.M. Krum, *Being Together in VR and AR*, Transmedia Institute International Symposium, Sungkyunkwan University, Seoul, South Korea, November 9, 2021.

IT.9 D.M. Krum, *Being Together in Virtual Environments*, Computer Science Colloquium, Pomona College, Claremont, California, October 21, 2021.

IT.8 D.M. Krum, *Reducing Social Distance with Immersive Technologies*, Transmedia Institute International Symposium, Sungkyunkwan University, Seoul, South Korea, November 6, 2020.

IT.7 D.M. Krum, *Virtual Reality and Augmented Reality For a Socially Distant World*, Korean-American Scientists and Engineers Association, Southern California Chapter, August 14, 2020.

IT.6 D.M. Krum, *How Can VR and AR Technologies Help Us During a Pandemic?*, presented at the Global VR-AR Conference 2020, Korea VR-AR Industry Association and Korean Ministry of Science and ICT, South Korea, July 20, 2020.

IT.5 D.M. Krum, *Reigniting Virtual Reality*, presented at the Hackaday Superconference, Pasadena, California, November 5, 2016.

IT.4 D.M. Krum, *Reigniting Virtual Reality*, presented to the cel Academy, Korea Creative Content Agency, Seoul, South Korea, August 26, 2016.

IT.3 D.M. Krum, *The Use of Wearable Computers as Spatial Cognition Aids*, presented to the Center for Lifelong Learning and Design, University of Colorado at Boulder, May 19, 2004.

IT.2 D.M. Krum, *Situational Visualization and Assistive Technology*, presented at the annual conference of the Rehabilitation Engineering & Assistive Technology Society of North America (RESNA), Atlanta, GA, June 20, 2003.

IT.1 D.M. Krum, *Visualization for Wearable Computers*, presented to the Visualization and Graphics Interest Group, University of Alabama in Huntsville, December 6, 2002.

Patents

P.7 M. Bolas, J.A. Jones, and D.M. Krum. *Control of Ambient and Stray Lighting in a Head Mounted Display.* US Patent: 10,416,453. Issued: September 17, 2019.

P.6 D. Krum, J. Faenger. *Context Aware Voice Communication Proxy for Vehicle Operators.* Submitted: October 2008.

P.5 J. Faenger, D. Krum. *Spatial Display and Selection Techniques.* Submitted: December 2007.

P.4 A. Keshavarzian, D. Krum, D. Lal, B. Srinivasan. *Smart Badges for Collective Workspaces.* US Patent Application: 11/521,279. Submitted: September 2006.

P.3 D.M. Krum. *Controlling Systems Through User Tapping.* US Patent: 8,339,363. Issued: December 25, 2012.

P.2 D.M. Krum H. Schmidt. *Sensor-Initiated Exchange of Information Between Devices.* Submitted: May 2005.

P.1 C. Lee, D.M. Krum, D. Ouyang. *Apparatus for and Method of Checking the Validity of Directory Numbers in a Device for Interfacing Communications Equipment to a Telephone Line.* US Patent: 5,917,807. Issued: June 29, 1999.

Awards and Honors

- Best Poster Award Honorable Mention, IEEE Virtual Reality Conference, 2019
- Best Poster Award, IEEE Virtual Reality Conference, 2017
- Best Demo Award, IEEE Virtual Reality Conference, 2012
- Best Paper Award Honorable Mention, IEEE Virtual Reality Conference, 2012
- Best Technote Award, IEEE 3DUI 2011
- Best Paper Award, IEEE Virtual Reality Conference, 2000
- SAIC Georgia Tech Student Paper Award, 2000, 2002
- Dean's List, University of Alabama in Huntsville, 1996
- National Merit Scholar, California Institute of Technology, 1990-1994
- Navy Reserve Officer's Training Corps Scholarship, 1990-1994
- Order of the Arrow, an honor society of the Boy Scouts of America, 1988
- Eagle Scout, 1987

CONTRIBUTIONS TO THE UNIVERSITY AND SERVICE ACTIVITIES

Chairs and Committees

- Senator: Academic Senate, Cal State LA, 2023-2025
- Director: Computer Science Supplementary Authorization Program, Cal State LA, 2021-Present
- Co-Director: Institute for Interactive Arts, Research, and Technology (InART), Cal State LA, 2021-Present
- Member: Eco-STEM Faculty Community of Practice, ECST, Cal State LA, 2022-2024
- Member: Equity, Diversity, and Inclusion Advisory Council, ECST, Cal State LA, 2021-Present
- Member: Computer Science Department Lecturer Evaluation Taskforce, Cal State LA, 2021-Present
- Member: Computer Science Department Student Affairs Committee, Cal State LA, 2021-Present
- Member: Computer Science Department Industrial Affiliates Board, Cal State LA, 2021-Present, Chair, 2021
- Computer Science Department Liaison: Math and Science Teacher Initiative (MSTI), Cal State LA, 2020-Present
- Member/Reviewer: IEEE Virtual Reality Best Dissertation Award Committee, 2021, 2022
- Conference Co-Chair: SPIE Virtual, Augmented, and Mixed Reality (XR) Technology for Multi-Domain Operations, 2020-Present
- Research Demonstrations Chair: IEEE Conference on Virtual Reality, 2020, 2021
- Video Chair: IEEE Conference on Virtual Reality, 2019
- Exhibits Chair: IEEE Conference on Virtual Reality, 2018
- General Chair: IEEE Conference on Virtual Reality, 2017
- Student Volunteer Chair: IEEE Conference on Virtual Reality, 2016
- Local Arrangements Chair: ACM Symposium on Spatial User Interaction, 2013

Reviewer

- IEEE Virtual Reality Conference
- IEEE Symposium on 3D User Interfaces
- ACM CHI Conference
- International Journal of Human-Computer Studies

Review Panels

- National Science Foundation, 2015, 2019

Organizations

- Member, Association for Computing Machinery (ACM), 1999-Present
- Institute of Electrical and Electronics Engineers (IEEE)
  - IEEE Impact Creator, 2020-Present
  - Senior Member, 2020-Present
  - Member, 1992-2020
  - Treasurer/Secretary, Los Angeles Metro Chapter, IEEE Engineering in Medicine and Biology Society (EMBS), 2021-Present
  - Member, IEEE Computing Society
  - Member, IEEE Engineering in Medicine and Biology Society
  - Member, IEEE Computer Society Technical Committee on Visualization and Graphics
  - Founding Secretary, Caltech IEEE Student Branch, 1993
- Member, National Academy of Inventors (NAI)
- Affiliated Member, USC Center for Wellness in the Built Environment, 2023-Present
- Member, USC SensoriMotor Assessment and Rehabilitation Training in Virtual Reality Center (USC SMART-VR Center)