

# GREGORY FRANCIS WELCH

*Curriculum Vitae—June 15, 2018*

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## CONTACT INFORMATION

University of Central Florida	Computer Science	Institute for Simulation and Training
College of Nursing	441 Harris Engineering Center	110 Partnership III
612 University Towers	4000 Central Florida Boulevard	3100 Technology Parkway
12201 Research Parkway	Orlando, FL 32816-2362 (USA)	Orlando, FL 32826-3281 (USA)
Orlando, FL 32826-3298 (USA)		

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## PROFESSIONAL EXPERIENCE (SUMMARY)

2011–present	<b>University of Central Florida</b> <i>Florida Hospital Endowed Chair in Healthcare Simulation</i> (2013) Professor, College of Nursing (2013) Professor, Computer Science, CECS (2011) Professor, Institute for Simulation & Training (2011) Co-Director, Synthetic Reality Lab (2011) Faculty, Modeling & Simulation Graduate Program (2011) Faculty, Interactive Computing Experiences Research Cluster of Excellence (2014)
1996–present	<b>University of North Carolina at Chapel Hill</b> Adjunct Professor, Computer Science (2012) Research Professor (Assistant, Associate), Computer Science (1996–2012)
1990–1992	<b>Northrop Defense Systems Division</b> Senior Engineer, Airborne Electronic Countermeasures, Digital Systems Group
1987–1990	<b>NASA Jet Propulsion Laboratory (California Institute of Technology)</b> Voyager Spacecraft Project, Flight Command and Data Management Section

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## EDUCATION

May 1997	<b>Ph.D., Computer Science</b> University of North Carolina at Chapel Hill, Chapel Hill, NC Under the direction of Gary Bishop
May 1995	<b>M.S., Computer Science</b> University of North Carolina at Chapel Hill, Chapel Hill, NC
May 1986	<b>B.S. with <i>Highest Distinction</i>, Electrical Engineering Technology</b> Purdue University, West Lafayette, IN

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## AWARDS AND HONORS

- Advisee award: Graduate advisee Salam Daher awarded Collegiate Award from the National Center for Women in Technology (NCWIT)—four recipients total, May 15, 2018, Grapevine, TX USA.
- IEEE Visualization and Graphics Technical Committee, 2018 Virtual Reality Technical Achievement Award, “in recognition for his contributions to human motion tracking and to mixed reality applications in medicine and training,” March 21, 2018 during the 25<sup>th</sup> IEEE Virtual Reality Conference in Reutlingen, Germany.
- *Best Student Paper Award*, 2017 ACM Symposium on Virtual Reality Software (VRST 2017), (Gothenberg, Sweden), for “Exploring the effects of observed physicality conflicts on real–virtual human interaction in augmented reality,” by Kangsoo Kim (student advisee), Gerd Bruder, and Greg Welch.
- Invited participant, Computing Community Consortium (CCC) Computing Research Symposium: Addressing National Priorities and Societal Needs 2017, October 23–24, 2017, Washington, DC.
- University of Central Florida Luminary Award for “exceptional faculty whose work is advancing their discipline and making a difference.” October 18, 2017.
- Advisee award: Salam Daher (Ph.D. advisee) recipient of I/ITSEC RADM Fred Lewis Scholarship Award, August 5, 2017.
- Invited participant, National Science Foundation Virtual Reality (VR)/Augmented Reality (AR) Workshop, July 17–18, 2017, Washington, DC.
- University of Central Florida Research Incentive Award (RIA) recipient, 2017.
- Invited participant, Computing Community Consortium (CCC) Visioning Workshop on Discovery and Innovation in Smart and Pervasive Health, December 5–6, 2016, Washington, DC.
- Long Lasting Impact Paper Award, 15<sup>th</sup> IEEE International Symposium on Mixed and Augmented Reality (ISMAR 2016), for a pair of 1998 papers on “Spatial Augmented Reality” (SAR), with co-authors Prof. Ramesh Raskar, Prof. Henry Fuchs, and Deepak Bandyopadhyay. September 20, 2016. Mérida, México.
- Rock StAR Award, 15<sup>th</sup> IEEE International Symposium on Mixed and Augmented Reality (ISMAR 2016), for teaching role in an introductory course on Augmented Reality (AR) for a group of approximately 40 Mexican students interested in AR. September 20, 2016. Mérida, México.
- Advisee award: Salam Daher (Ph.D. advisee) recipient of Link Foundation Fellowship in Modeling, Simulation, and Training for the 2016–2017 academic year, March 16, 2016.
- Certificate of Appreciation for two-day course on an “Introduction to the Kalman Filter” for Autonomy Incubator Short Course Series (AISCS), NASA Langley Research Center (LaRC), Hampton, Virginia, November 5–6, 2014.
- IEEE Computer Society award for “Outstanding Performance as Co-Chairman of the IEEE VR 2014 Conference,” April 3, 2014.
- IEEE Computer Society award for “Outstanding Performance as Co-Chairman of the IEEE VR 2013 Conference,” March 18, 2013.
- Invited speaker/participant, National Research Council (NRC) Mapping Science Committee meeting, October 3, 2012, National Academies Keck Center, Washington, DC, USA.
- Invited speaker/participant, Computing Community Consortium (CCC) Visioning Workshop on Spatial Computing, September 10–11, 2012, National Academies Keck Center, Washington, DC, USA.

- Awarded *2<sup>nd</sup> Prize Best ICDSC 2011 Paper* at 5th ACM/IEEE International Conference on Distributed Smart Cameras, August 22–25, 2011.
- Advisee award: Undergraduate advisee Joshua Morton awarded a Rodney F. Hood Undergraduate Research Award in support of “Tremor Sensing and Quantification” (November 15, 2010–June 30, 2011).
- Featured exhibit, Collaborations: Humanities, Arts & Technology (CHAT) Festival, “The Bathysphere: Motion Capture as Art,” with Prof. Francesca Talenti, February 16–20, 2010, UNC-Chapel Hill.
- *Excellence in Teaching* award, UNC-Chapel Hill, Computer Science Student Association, for 3D Computer Modeling and Animation, Spring 2007
- *Best Paper*, ACM Symposium on Virtual Reality Software and Technology 1999 (VRST 99)
- Internationally-recognized Kalman filter web site (<http://www.cs.unc.edu/~welch/kalman/>)

## PROFESSIONAL SERVICE

- Professional Associations
  - Senior Member, Institute of Electrical and Electronics Engineers (IEEE)
  - Member, Association for Computing Machinery (ACM)
  - Pioneer, ACM Special Interest Group on Computer Graphics and Interactive Techniques (SIGGRAPH)
  - Member, Vision Sciences Society (VSS)
  - Member, European Association for Computer Graphics (Eurographics)
  - Member, Society for Simulation in Healthcare (SSIH)
  - Member, International Nursing Association of Clinical Simulation and Learning (INACSL)
  - Member, Southern Nursing Research Society (SNRS)
- Boards and Committees
  - Member, Futures Task Force, National Council of Architectural Registration Boards (NCARB) (2017-present)
  - Steering Committee, Florida Hospital East Orlando Simulation Center (2015–present)
  - Steering Committee, International Symposium for Mixed & Augmented Reality (2012–present)
  - Advisory Committee, IST Modeling & Simulation Graduate Program (2012–present)
  - Information Technology Resource Advisory Committee, UCF (2014–present)
  - Senior Advisor, TrakMark Working Group—SIG MR and VR Society of Japan (past)
  - Board of Directors, HiBall Tracker, Inc. (past)
  - UNC-Chapel Hill Committee on Student Conduct (past)
  - UNC-Chapel Hill Computer Science Committee on Curriculum and Planning (past)
  - UNC-Chapel Hill Computer Science Committee on Publications (past)
- Reviewer, Committee, and Editorial Activity
  - Reviewer/panelist for the U.S. National Science Foundation (NSF), U.S. Department of Energy (DOE), and other funding organizations/units.
  - Associate Editor of *Presence: Teleoperators and Virtual Environments* (2002–present)
  - Associate Editor of *Frontiers in Virtual Environments* (2014–present)
  - Editorial Board of *Journal of Virtual Reality* (past)

- ACM: International Conference on Graphics and Interactive Techniques (SIGGRAPH); Symposium on Virtual Reality Software and Technology (VRST); Symposium on Interactive 3D Graphics; Multimedia; User Interface Software and Technology (UIST); Transactions on Mathematical Software;
  - IEEE: Computer Graphics and Applications (CG&A); International Symposium on Mixed and Augmented Reality (ISMAR)—Area Chair; Virtual Reality (VR); Transactions on Visualization and Computer Graphics; Transactions on Aerospace and Electronic Systems; Conference on Computer Vision and Pattern Recognition (CVPR)
  - International Symposium on 3D Data Processing, Visualization, and Transmission (3DPVT)
  - International Symposium on Ubiquitous Virtual Reality (ISUVR)
  - IEEE/ACM International Symposium on Wearable Computers
  - The combined International Conference on Artificial Reality & Telexistence and Eurographics Symposium on Virtual Environments (ICAT-EGVE)
  - EURASIP Journal of Applied Signal Processing; Transactions on Automatic Control
  - Journal of Optimal Control Applications and Methods
  - Eurographics Workshop on Virtual Environments
  - New Immersive Displays for the Near Future (Laval Virtual 2011 Symposium)
- Developer of popular Mac OS X Mail plugins MailFollowUp and MailRecent
  - Consultant on Virtual Reality, human position and motion estimation, sensor fusion, graphics, and human-computer interaction.
- Event Organization
    - VR 2019 Program Committee Co-Chair, IEEE Virtual Reality 2019 (Osaka, Japan), with Bruce Thomas (University of South Australia in Adelaide, Australia), Torsten Kuhlen (RWTH Aachen University, Aachen, Germany), and Rob Teather (Carleton University, Ottawa, Canada).
    - VR 2018 Program Committee Co-Chair, IEEE Virtual Reality 2018 (Germany), with Kiyoshi Kiyokawa (Osaka University, Japan), Frank Steinicke (University of Hamburg, Germany), and Bruce Thomas (University of South Australia in Adelaide, Australia).
    - “Virtual and Augmented Reality for Good” (VAR4Good) workshop, 25<sup>th</sup> IEEE Conference on Virtual Reality and 3D User Interfaces (VR 2018), co-organized with Bruce Thomas, Arindam Dey, and Mark Billinghurst (all University of South Australia in Adelaide, Australia), March 18, 2018, Reutlingen, Germany.
    - “Augmented Reality for Good” (AR4Good) workshop, 16<sup>th</sup> IEEE International Symposium on Mixed and Augmented Reality (ISMAR 2017), co-organized with Arindam Dey and Mark Billinghurst (both University of South Australia in Adelaide, Australia), October 9, 2017, Nantes, France.
    - Combined 26<sup>th</sup> International Conference on Artificial Reality and Telexistence (ICAT 2016) and 21<sup>st</sup> Eurographics Symposium on Virtual Environments (ICAT-EGVE 2016) *Best Paper* awards committee, December 7–9, 2016. Little Rock, Arkansas, USA.
    - ACM Symposium on Virtual Reality Software and Technology (VRST 2016) *Best Paper* awards committee, November 2–4, 2016. Munich, Germany.
    - 15<sup>th</sup> IEEE International Symposium on Mixed and Augmented Reality (ISMAR 2016), co-organized “AR101,” an introductory course on Augmented Reality (AR) for a group of approximately 40 Mexican students interested in AR. September 20, 2016. Mérida, México.
    - 15<sup>th</sup> IEEE International Symposium on Mixed and Augmented Reality (ISMAR 2016), Best Paper Award committee, September 19–23, 2016. Mérida, México.

- ISMAR 2016 Outreach Co-Chair, IEEE International Symposium on Mixed and Augmented Reality (ISMAR2016), Mérida, México, September 19–23, 2016.
- Workshop “Human Perception and Psychology in Augmented Reality (HPPAR),” with Bruce H. Thomas (The University of South Australia Mawson Lakes) and James Baumeister (University of South Australia), IEEE International Symposium on Mixed and Augmented Reality (ISMAR2015), September 29, 2015, Fukuoka, Japan.
- Dagstuhl Seminar on “Virtual Realities” (Seminar 13241), co-organized with Guido Brunnett (TU Chemnitz, Germany), Sabine Coquillart (INRIA Rhône-Alpes, France), and Robert van Liere (Center for Mathematics and Computer Science, Netherlands), June 10–14, 2013, The International Conference and Research Center for Computer Science, Dagstuhl, Germany.
- IEEE Virtual Reality 2013 (VR 2013), Co-General Chair with Ben Lok (University of Florida), March 16–23, 2013, Orlando, FL, USA.
- 11<sup>th</sup> International Symposium on Mixed and Augmented Reality (ISMAR 2012), Co-General Chair with Blair MacIntyre (Georgia Tech), November 5–8, 2012, Atlanta, Georgia, USA.
- Joint Virtual Reality Conference 2011 (JVRC 2011), International Program Committee Co-chair with Sabine Coquillart (INRIA Rhône-Alpes, France) and Anthony Steed (University College of London, UK).
- 10<sup>th</sup> International Symposium on Mixed and Augmented Reality (ISMAR 2011), Program Committee Co-Chair with Gerhard Reitmayr (Graz University of Technology) and Jun Park (Hongik University).
- VR 2011 Research Demos Co-Chair, IEEE Virtual Reality 2011 (Singapore), with Dirk Reiners (University of Louisiana at Lafayette, USA), Henry Duh (National University of Singapore), and Jiung-Yao Huang (National Taipei University, Taiwan).
- VR 2010 Research Demos Co-Chair, IEEE Virtual Reality 2010 (Waltham, MA, USA), with Yoshifumi Kitamura (Osaka University, Japan), Laura Monroe (Los Alamos National Laboratories, USA), Dirk Reiners (University of Louisiana at Lafayette, USA), and Simon Richir (Laval Virtual, France)
- Dagstuhl Seminar on “Virtual Realities” (Seminar 08231), co-organized with Guido Brunnett (TU Chemnitz, Germany) and Sabine Coquillart (INRIA Rhône-Alpes, France), June 1–6, 2008, The International Conference and Research Center for Computer Science, Dagstuhl, Germany
- VR 2007 Local Arrangements Co-Chair, IEEE Virtual Reality 2007 (Charlotte, NC, USA), with Zachary Wartell (UNC-Charlotte, USA), Sabarish Babu (UNC-Charlotte, USA), and Regis Kopper (Virginia Tech, USA)
- Workshops/Tutorials Chair, 5<sup>th</sup> IEEE and ACM International Symposium on Mixed and Augmented Reality (Santa Barbara, CA, USA)
- Co-Chair with Chris Jaynes (University of Kentucky) of IEEE CVPR 2006 International Workshop on Projector-Camera Systems, (ProCams 2006), New York, NY, USA.
- 3DPVT 2006 Organizing Committee, Third International Symposium on 3D Data Processing, Visualization and Transmission (Chapel Hill, NC, USA)
- EDT 2006 Co-chair, IEEE Virtual Reality 2006 International Workshop on Emerging Display Technologies (Alexandria, VA, USA), with Mark Bolas (USC and Fakespace Labs) and Andreas Simon (FH-Aargau)
- ICAT 2005 Program Co-Chair, 15<sup>th</sup> International Conference on Artificial Reality and Telexistence (Christchurch, New Zealand), with Sang Chul Ahn (KIST, Korea), and Haruo Noma (ATR, Japan)
- ProCams 2005 Posters Chair, IEEE CVPR 2005 International Workshop on Projector-

Camera Systems (San Diego, CA, USA)

- EDT 2005 Co-chair, IEEE Virtual Reality 2005 International Workshop on Emerging Display Technologies (Bonn, Germany), with Mark Bolas (USC and Fakespace Labs) and Andreas Simon (Fraunhofer IMK)
- I3D 2001 Registration Chair, ACM Symposium on Interactive 3D Graphics (Chapel Hill, NC, USA)

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## KEYNOTE TALKS

- New Knowledge and Innovations, Sarasota Memorial Health Care System, Sarasota, Florida, May 4, 2018.
- International Conference on Computer-Aided Design and Computer Graphics (CAD/Graphics), Zhangjiajie, China, August 26, 2017.
- Society for Design and Process Science conference (SDPS), Orlando, Florida, December 5, 2016.
- Annual Meeting of the Association for Information Science and Technology (ASIS&T), Copenhagen, Denmark, October 16, 2016.
- 22nd Annual Research Day, Sigma Theta Tau International Honor Society of Nursing, Theta Epsilon chapter, Winter Park, Florida, USA, April 8, 2014.
- Society for Computer Science, Workshop on Virtual Reality-Augmented Reality (GI VR-AR 2013), Würzburg, Germany, September 19, 2013.
- International Symposium on Ubiquitous Virtual Reality (ISUVR), Daejeon, South Korea, August 23, 2012.
- Joint Virtual Reality Conference (JVRC), Fellbach, Germany, September 29, 2010.
- Winter Augmented Reality Meeting (WARM), Graz, Austria, February 24–25, 2010.
- Real Action, Virtual Environments (RAVE), Barcelona, Spain, March 4, 2009
- Digital City Monitoring and Emergency Management (D2D), Shenzhen, China, October 25, 2008
- Eurographics Symposium on Virtual Environments (EGVE), Eindhoven, The Netherlands, May 29, 2008

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## OTHER INVITED TALKS (SELECTED)

- “Human Surrogates and their Effects on Humans,” Naval Postgraduate School, MOVES Institute, Simulation and Training Course, Monterey, CA, September 8, 2016
- “Human Surrogates and their Effects on Humans,” Technische Universität München (TU Munich), Garching b. Munich, Germany, June 28, 2016
- “Interactive Rear-Projection Physical-Virtual Patient Simulators,” Mini-Lecture at NextMed / MMVR22 (Medicine Meets Virtual Reality), Los Angeles, CA, April 7, 2016.
- “Making the Virtual Real: Virtual Reality, Augmented Reality, Physical-Virtual Reality,” Examination Development & Research committee of the National Council of Architectural Registration Boards (NCARB), Phoenix, AZ, January 30, 2016.
- “My patient is a dummy—so why should I care?” classroom lecture, Rollins College (Winter Park, FL), hosted by Darin Hughes, November 11, 2015.

- “Making the Virtual Real: Physical Manifestations of Dynamic Virtual People, Objects, and Places,” Qualcomm/Vienna University of Technology (Vienna, Austria), September 15, 2014.
- “Making the Virtual Real: Physical Manifestations of Dynamic Virtual People, Objects, and Places,” Graz University of Technology (Graz, Austria), September 17, 2014.
- “Past and Current Research in Modeling and Reproducing Humans for Warfighter Training,” Orlando VA Medical Center (Orlando, FL), August 26, 2014.
- “Making the Virtual Real: Physical Manifestations of Dynamic Virtual People, Objects, and Places,” Harris Corporation, Melbourne, FL, February 18, 2014.
- “Face-to-Face: Interactive Simulation Using a Mobile Physical-Virtual Patient,” work with Steven Talbert, Mary Lou Sole, and Karen J. Aroian, SNRS 28<sup>th</sup> Annual Conference, San Antonio, TX, February 15, 2014.
- “Physical-Virtual Humans for Healthcare,” the University of Texas at San Antonio, San Antonio, TX, February 13, 2014.
- “Physical-Virtual Humans for Training and Teleportation,” Max Planck Institute, Tübingen, Germany, September 17, 2013, and Bonn-Rhein-Sieg University of Applied Sciences, Bonn, Germany, September 20, 2013.
- “Interactive Shader Lamps: Projector-Based Graphics in Motion,” GI VR-AR (Würzburg, Germany), September 19, 2013.
- “Physical-Virtual Humans for Training and Teleportation,” TU Chemnitz (Chemnitz, Germany), June 6, 2013.
- “Physical-Virtual Humans: Challenges and Opportunities”, KIST (Seoul, South Korea) and KAIST (ISUVR 2012, Daejeon, South Korea), August 22–23, 2012.
- “Physical Manifestations of Virtual Humans,” Technische Universität München (TU Munich); Garching b. Munich, Germany; April 11, 2011
- “Crossing Realities: The Convergence of Physical and Virtual Worlds,” Microsoft Research; Redmond, WA; May 25, 2010
- “Crossing Realities: An Overview of Related Work at UNC-Chapel Hill,” Joint Virtual Reality Conference (JVRC); Lyon, France; December 7, 2009
- “Virtual Artifacts and Experiences in Real Environments,” second RAVE 2009 workshop (Real Action, Virtual Environments); Barcelona, Spain; March 4, 2009
- “A Living, Breathing, Dynamic Digital City,” D2D 2008 workshop (Digital City Monitoring and Emergency Management); Shenzhen, China; October 25, 2008
- “Immersive Display Research at UNC-CH: A Sampling,” with Henry Fuchs; Max Planck Institute, Tübingen, Germany; June 9, 2008.
- “Motion Tracking as an Epic Battle Between Information and Uncertainty,” 14<sup>th</sup> Eurographics Symposium on Virtual Environments (EGVE 2008); Eindhoven, The Netherlands; May 29, 2008.
- “Improving, Expanding and Extending 3D Telepresence,” International Workshop on Advanced Information Processing for Ubiquitous Networks, ICAT 2005; Christchurch, New Zealand; December 8, 2005.
- “3D Telepresence for Off-Line Surgical Training and On-Line Remote Consultation,” 2<sup>nd</sup> CREST Symposium on Telecommunication, Teleimmersion and Telexistence; University of Tokyo; December 9–10, 2004.
- “Immersive Telepresence for Surgical Teaching and Remote Consultation: Extending Medical Expertise Over Time and Space,” University of Florida, Department of Computer and Information Science and Engineering; “Geometry, Graphics, Vision, Visualization/ Simulation (G2V2)” seminar series; October 17, 2003.
- “Sensor Information Efficiency for Pose Estimation,” University of Rochester, Department of

Computer Science; April 13, 2001.

- “Inside the HiBall Tracking System,” Siemens Corporate Research, Imaging and Visualization Department; Princeton, NJ; October 25, 2000.
- “Tracking for Interactive Computer Graphics: To the Hallway and Beyond,” the Boeing Corporation, Virtual Reality Group, Seattle, WA, April 21, 1999. (Also presented at Microsoft Research; Seattle, WA; April 21, 1999.)
- “Spatially-Augmented Visualization,” Walt Disney Imagineering, Virtual Reality Studio; Burbank, CA; September 1998.

## PANEL PARTICIPATION

- Anthony Steed (University College London), Doron Friedman (IDC Herzliya), **Greg Welch** (UCF), Susumu Tachi (The University of Tokyo), and moderator Mel Slater (University of Barcelona), “Instantaneous Beaming to Distance Places — A Possible and Desirable Future?” IEEE Virtual Reality 2017, March 21, Los Angeles, CA USA.
- **Greg Welch** (UCF), Charles Hughes (UCF), Linda Gibson-Young (UCF), Chait Renduchintala (UCF), Peter Kincaid (UCF), Sarah Matthews (FL DOH), Tom Herring (FL DOH), “Technology & Public Health Use Now and in the Future,” 2014 Florida Public Health Educational Meeting, Orlando, FL, August 1, 2014.
- Betty Mohler (Max Planck Institute for Biological Cybernetics), **Greg Welch** (UNC-CH), Daniel Thalmann (Nanyang Technological University and EPFL), and Victoria Interrante (University of Minnesota), “Avatars in Virtual Environments,” IEEE Virtual Reality 2011 (VR 2011), Singapore, March 21, 2011.
- Randy Harrell (CISCO), Jaron Lanier (Microsoft), Frantz Lohier (Logitech), **Greg Welch** (UNC-CH), William C. Wickes (Hewlett Packard), and Zhengyou Zhang (Microsoft Research), IMMERSCOM 2009 (2<sup>nd</sup> International Conference on Immersive Telecommunications), May 29, 2009.
- Henry Fuchs, Bernd Fröhlich (Bauhaus-Universität Weimar), and **Greg Welch**, “Display Technology,” 14<sup>th</sup> Eurographics Symposium on Virtual Environments (EGVE 2008), Eindhoven, The Netherlands, May 30, 2008.
- Barbara Hayes-Roth, Austin Henderson, Ramesh Jain, Lev Manovich, **Greg Welch**, and Gopal Pingali, “Experiential Telepresence: How Can Telepresence Research be Guided Towards Better End User Experience?” ACM SIGMM 2003 Workshop on Experiential Telepresence 2003 (ETP 2003), November 7, 2003, Berkeley, CA USA.

## GRADUATED PH.D. ADVISEES AND DISSERTATION TITLES

- Peter Lincoln, 2017 (UNC Chapel Hill, with Henry Fuchs): Low Latency Displays for Augmented Reality
- Christoph Resch, 2016 (TU München, with Gudrun Klinker): Enhancing Projective Spatial Augmented Reality in Industry: A Model Based Approach for Registration and Calibration
- Feng Zheng, 2015 (UNC Chapel Hill): Spatio-Temporal Registration in Augmented Reality
- Jinghe Zhang, 2013 (UNC Chapel Hill): Uncertainty-Driven Adaptive Estimation with Applications in Electrical Power Systems
- Peter Keitler, 2011 (TU München, with Gudrun Klinker): Management of Tracking and Tracking Accuracy in Industrial Augmented Reality Environments
- Adrian Ilie, 2010: On-Line Control of Active Camera Networks



- Hua Yang, 2008: Differential Tracking Through Sampling and Linearizing the Local Appearance Manifold
- B. Danette Allen: 2007, Hardware Design Optimization for Human Motion Tracking Systems
- Aditi Majumder, 2003: A Practical Framework To Achieve Perceptually Seamless Multi-Projector Displays
- Ruigang Yang, 2003: View-Dependent Pixel Coloring—A Physically-Based Approach for 2D View Synthesis
- Ramesh Raskar, 2001: Projector-Based Three Dimensional Graphics

#### GRADUATED M.S. AND B.S. HONORS THESIS ADVISEES

- Angelica Garcia, 2017 (UCF M.S. Modeling & Simulation, Advisor)
- Justin Grace, 2016: Recognizing Pain Using Novel Simulation Technology (UCF B.S.N. Honors in the Major, Committee Member)
- Krishna Kollu, 2012: Modeling the Neural Pathology of Parkinson’s Disease (UNC B.S. C.S. Honors, Advisor)
- Caitlyn Losee, 2011: The Bathysphere: Motion Capture and Immersive Projection (UNC B.S. C.S. Honors, Advisor)

#### STUDENT ADVISEES (ALL)

Salam Daher (current); Jason Hochreiter (current); Yazdan Jamshidi (current); Kang-soo Kim (current); Myungho Lee (current); Nahal Norouzi (current); Ryan Schubert (current); Brandon Belna (JUN–AUG 2017, NSF REU); Peter Lincoln (2017, Ph.D., with Henry Fuchs); Christoph Resch (2016, Ph.D., TU München, with Gudrun Klinker); Kiran Pandit (JUN–AUG 2016, NSF REU); Feng Zheng (2015, Ph.D.); Ryan Patrick (2013, M.S.); Jinghe Zhang (2013, Ph.D.); Krishna Kollu (2012, B.S. Undergraduate Honors); Caitlyn Losee (2011, B.S. Undergraduate Honors); Peter Keitler (2011, Ph.D., TU München, with Gudrun Klinker); Adrian Ilie (2010, Ph.D.); Hua Yang (2008, Ph.D.); Danette Allen (2007, Ph.D.); Vincent Noel (2006, M.S.); Michael Noland (2006, M.S.); Aditi Majumder (2003, Ph.D.); Ruigang Yang (2003, Ph.D.); and Ramesh Raskar (2001, Ph.D.).

#### STUDENT COMMITTEES

Alex Blate (current, Ph.D.); Kyle Martin (current, Ph.D.); Kevin Pfeil (current, Ph.D.); Remo Pillat (current, Ph.D.); Corey Pittman (current, Ph.D.); Min Wang (current, Ph.D.); Baoyuan Liu (2016, Ph.D., Amazon); Rick Skarbez (2016, Ph.D.); Alexandra Carson (2016, BSN Honors in the Major); Justin Grace (2016, BSN Honors in the Major); Monika Schaeffer @ Duke University (2011, M.S.); Brian Clipp (2010, Ph.D., URC Ventures); David Gallup (2010, Ph.D., Google); Andrew Nashel (2010, Ph.D., Cisco Systems); Tyler Johnson (2009, Ph.D., Scalable Displays); Seon Joo Kim (2008, Ph.D., postdoc, National University of Singapore); examiner for Philip McLeod @ University of Otago (2008, Ph.D.); Patrick Quirk (2006, M.S., SportsMEDIA Technology Corporation); Kok-Lim Low (2005, Ph.D., National University of Singapore); Lindsey McCarthy (2011, M.S. Dentistry); Michael Rosenthal (2005, Ph.D., Dana-Farber Cancer Institute); Benjamin Lok (2002, Ph.D., University of Florida); Nicholas Vallidis (2002, Ph.D., Na-

tional Robotics Engineering Consortium); Gopi Meenakshisundaram (2001, Ph.D., University of California at Irvine); Mark Livingston (1998, Ph.D., Naval Research Lab); and Hans Weber (Sports Media Technology Corporation).

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### THESIS EXAMINER (INTERNATIONAL)

- Michael Robert Marner, “Physical-Virtual Tools for Interactive Spatial Augmented Reality,” The University of South Australia; Principal Supervisor: Prof. Bruce Hunter Thomas, Associate Supervisor Prof. Christian Sandor; 2013.
- Philip Grant McLeod, “Fast, Accurate Pitch Detection Tools for Music Analysis,” the University of Otago; 2008.

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### CLASSROOM TEACHING

- *3D Computer Modeling and Animation*, First Year Seminar, UNC-CH, 2003–2007. Created the course, which was chosen by UNC from among competing First Year Seminar proposals. Awarded Computer Science Student Association *Excellence in Teaching* award, Spring 2007
- *Introduction to Programming (Java)*, UNC-CH, 2002–2003
- *Team Software Engineering*, UNC-CH, 2001 (Spring)
- *Exploring Virtual Worlds*, UNC-CH, 1997–1998
- NSF STC Center-Wide Lecture Series, coordinated within the Center, 1997
- *Computers: Power Tools for the Mind*, UNC-CH, 1995

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### TUTORIALS/SHORT COURSES

- AR101 (An Introduction to Augmented Reality), 15<sup>th</sup> IEEE International Symposium on Mixed and Augmented Reality (ISMAR 2016), September 18, 2016. Mérida, México. Co-taught with Mark Billinghurst, Tobias Höllerer, Dieter Schmalstieg, Gerhard Reitmayr, Kiyoshi Kiyokawa, and Steve Feiner.
- **Greg Welch**. “An Introduction to the Kalman Filter,” NASA Langley Research Center, National Institute of Aerospace, Hampton, VA USA, November 5–6, 2014.
- **Greg Welch**. “Tracking: Beyond 15 Minutes of Thought” and “An Introduction to the Kalman Filter,” University of Würzburg, Interactive Intelligent Spaces Summer School, Würzburg, Germany, September 13–14, 2013.
- **Greg Welch** and Gary Bishop. “An Introduction to the Kalman Filter,” ACM SIGGRAPH 2001 tutorial, August 12, 2001, Los Angeles, CA USA.
- **Greg Welch**, Gerhard Reitmayr (Graz Univ. of Tech.), Vincent Lepetit (Swiss Federal Institute of Tech.), and Brian Clipp (UNC-Chapel Hill), “Tracking for AR Tracking Researchers,” International Symposium on Mixed and Augmented Reality (ISMAR 2009), October 19, 2009.
- **Greg Welch** and Gary Bishop. “An Introduction to the Kalman Filter,” ACM SIGGRAPH 2001 tutorial, August 12, 2001, Los Angeles, CA USA.
- B. Danette Allen, Gary Bishop and **Greg Welch**. “Tracking: Beyond 15 Minutes of Thought,” ACM SIGGRAPH 2001 short course, August 12, 2001, Los Angeles, CA USA.
- “An Introduction to the Kalman Filter,” multi-day seminars offered periodically at UNC Chapel Hill, 1996–2009.

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**BOOKS, CHAPTERS, AND SECTIONS**

- Guido Brunnett, Sabine Coquillart, Robert van Liere, **Greg Welch**, and Libor Váša, editors. *Virtual Realities: International Dagstuhl Seminar, Dagstuhl Castle Germany; June 9–14, 2013; Revised Selected Papers*. Number 8844 in Lecture Notes in Computer Science. ISBN: 978-3-319-17042-8, Springer, 2015.
- Charles Hughes, Arjun Nagendran, Lisa Dieker, Michael Hynes, and **Greg Welch**. Applications of avatar mediated interaction to teaching, training, job skills and wellness. In Brunnett, G., Coquillart, S., van Liere, R., Welch, G., and Váša, L., editors, *Virtual Realities*, volume 8844 of *Lecture Notes in Computer Science*, pages 133–146. Springer International, 2015.
- Arjun Nagendran, **Greg Welch**, Charles Hughes, and Remo Pillat. Technical report: Exploring human surrogate characteristics. In Brunnett, G., Coquillart, S., van Liere, R., Welch, G., and Váša, L., editors, *Virtual Realities*, volume 8844 of *Lecture Notes in Computer Science*, pages 215–228. Springer International, 2015.
- Sabine Coquillart, Guido Brunnett, and **Greg Welch**, eds., *Virtual Realities: Dagstuhl Seminar 2008*. 1st Edition., 2011, XIII, 251 p. 78 illus., Softcover. ISBN: 978-3-211-99177-0, Springer, 2011.
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- [9] **Greg Welch**, Michael Noland, and Gary Bishop, Complementary Tracking and Two-Handed Interaction for Remote 3D Medical Consultation with a PDA, Proceedings of Trends and Issues in Tracking for Virtual Environments, Workshop at the IEEE Virtual Reality 2007 Conference (Charlotte, NC USA) (Gabriel Zachmann, ed.), Shaker, March 11 2007.
- [8] Ruigang Yang, Liang Wang, **Greg Welch**, and Marc Pollefeys. Stereovision on GPU. In Proceedings of the 2006 Workshop on Edge Computing Using New Commodity Architectures (EDGE 2006), May 23–24 (Chapel Hill, NC, USA).
- [7] **Greg Welch**, Hua Yang, Andrei State, Vincent Noel, Adrian Ilie, Ruigang Yang, Marc Pollefeys, and Henry Fuchs. GPU-Based View Synthesis Using an Orbital Reconstruction Frustum. In Proceedings of the 2006 Workshop on Edge Computing Using New Commodity Architectures (EDGE 2006), May 23–24 (Chapel Hill, NC, USA).
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- [5] Aditi Majumder and **Greg Welch**. Computer Graphics Optique: Optical Superposition of Projected Computer Graphics. In *Fifth Immersive Projection Technology Workshop, in conjunction with the Seventh Eurographics Workshop on Virtual Environments*, Stuttgart, Germany, 2001. Springer-Verlag.
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- [3] Ramesh Raskar, **Greg Welch**, and Henry Fuchs. Spatially Augmented Reality. In Reinhold Behringer, Gudrun Klinker, and David Mizell, editors, *Augmented Reality; Placing Artificial Objects in Real Scenes* Proceedings of the First IEEE Workshop on Augmented Reality (IWAR?98), pages 63–72. A.K. Peters Ltd., San Francisco, CA, USA (November 1, 1998), 1998. ISBN 1-56881-098-9. “Long Lasting Impact Paper” award, 15<sup>th</sup> IEEE International Symposium on Mixed and Augmented Reality (ISMAR 2016).
- [2] Ramesh Raskar, Matthew Cutts, **Greg Welch**, and Wolfgang Stürzlinger. Efficient Image Generation for Multiprojector and Multisurface Displays. In George Drettakis and Nelson Max, editors, *Proceedings of the Eurographics Workshop in Vienna, Austria*, pages 139–144. Springer

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- [1] Ronald T. Azuma, Bruce R. Hoff, Howard E. Neely III, Ronald Sarfaty, Michael J. Daily, Gary Bishop, Vernon Chi, **Greg Welch**, Ulrich Neumann, Suya You, Rich Nichols, and Jim Cannon. Making Augmented Reality Work Outdoors Requires Hybrid Tracking. In *First International Workshop on Augmented Reality*, pages 219–224, San Francisco, CA, USA, 1998.

## INVITED AND OTHER PUBLICATIONS

- [13] Laura Gonzalez, Salam Daher, Jason Hochreiter, and **Greg Welch**. (2016). Student nursing assessment of discrete neurology symptoms using an interactive physical virtual head. Presentation at the 2016 meeting of the *International Nursing Association for Clinical Simulation and Learning*, June 16, 2016.
- [12] **Greg Welch**, Arjun Nagendran, Jeremy Bailenson, Charles Hughes, Pete Muller, and Peter Squire (2014). Mastering the Human Element of Immersive Training, in *Naval Science and Technology Future Force*, Fall 2014:10–13.
- [11] Giodo Brunnett, Sabine Coquillart, Robert van Liere, and **Greg Welch**, “Virtual Realities (Dagstuhl Seminar 13241),” *Dagstuhl Reports*, vol. 3, no. 6, pp. 38–66, 2013.
- [10] **Greg Welch**, Physical-virtual humans: Challenges and opportunities. In *Ubiquitous Virtual Reality (ISUVR), 2012 International Symposium on*, pp. 10 –13, aug. 2012.
- [9] Guido Brunnett, Saine Coquillart, and **Greg Welch**, “08231 abstracts collection – virtual realities,” in *Virtual Realities* (Guido Brunnett, Sabine Coquillart, and **Greg Welch**, eds.), no. 08231 in Dagstuhl Seminar Proceedings, (Dagstuhl, Germany), Schloss Dagstuhl - Leibniz-Zentrum fuer Informatik, Germany, 2008.
- [8] Amir Akbarzadeh, Jan-Michael Frahm, Philippos Mordohai, Brian Clipp, Chris Engels, David Gallup, Paul Merrell, Michael Phelps, Sudipta Sinha, Brad Talton, Liang Wang, Qing-Xiong Yang, Henrik Stewenius, Ruigang Yang, **Greg Welch**, Herman Towles, David Nistér, and Marc Pollefeys. Towards Urban 3D Reconstruction From Video. In *Proceedings of the Third International Symposium on 3D Data Processing, Visualization and Transmission (3DPVT 2006)*, Chapel Hill, NC, June 2006.
- [7] Andrei State, **Greg Welch**, and Adrian Ilie. An Interactive Camera Placement and Visibility Simulator for Image-Based VR Applications. In *Proceedings of the Engineering Reality of Virtual Reality 2006 (3D Imaging, Interaction, and Measurement; IS&T/SPIE 18<sup>th</sup> Annual Symposium on Electronic Imaging Science and Technology)*, San Jose, CA, January 2006.
- [6] **Greg Welch**, Henry Fuchs, Bruce Cairns, Ketan Mayer-Patel, Diane H. Sonnenwald, Ruigang Yang, Andrei State, Herman Towles, Adrian Ilie, Michael Noland, Vincent Noel, and Hua Yang. Improving, Expanding and Extending 3D Telepresence. In *Proceedings of the 2005 International Workshop on Advanced Information Processing for Ubiquitous Networks*, with ICAT 2005, Christchurch, New Zealand, December 8, 2005.
- [5] Hua Yang and **Greg Welch**. Model-Based 3D Object Tracking Using an Extended-Extended Kalman Filter and Graphics Rendered Measurements. In *Proceedings of 1<sup>st</sup> Computer Vision for Interactive and Intelligent Environments (CV4IIE) workshop*, University of Kentucky, Lexington, KY.

- [4] **Greg Welch**, Ruigang Yang, Bruce Cairns, M.D., Herman Towles, Andrei State, Adrian Ilie, Sascha Becker, Dan Russo, Jesse Funaro, Diane Sonnenwald, Ketan Mayer-Patel, B. Danette Allen, Hua Yang, Eugene Freid, M.D., Andy van Dam, and Henry Fuchs. 3D Telepresence for Off-Line Surgical Training and On-Line Remote Consultation. Susumu Tachi, editor, *Proceedings of ICAT CREST Symposium on Telecommunication, Teleimmersion, and Telexistence*, The University of Tokyo, Tokyo, Japan, December 2004.
- [3] Andries van Dam, Henry Fuchs, Sascha Becker, Loring Holden, Adrian Ilie, Kok-Lim Low, Anne Morgan Spalter, Ruigang Yang, and **Greg Welch**. Immersive Electronic Books for Teaching Surgical Procedures. In Susumu Tachi, editor, *Proceedings of ICAT CREST Symposium on Telecommunication, Teleimmersion, and Telexistence*, The University of Tokyo, Tokyo, Japan, December 2002.
- [2] **Greg Welch** and Gary Bishop. An Introduction to the Kalman Filter: SIGGRAPH 2001 course 8. In *Computer Graphics, Annual Conference on Computer Graphics & Interactive Techniques*. ACM Press, Addison-Wesley, Los Angeles, CA, USA (August 12–17), SIGGRAPH 2001 course pack edition, 2001.
- [1] Bonnie Danette Allen, Gary Bishop, and **Greg Welch**. Tracking: Beyond 15 Minutes of Thought: SIGGRAPH 2001 course 11. In *Computer Graphics, Annual Conference on Computer Graphics & Interactive Techniques*. ACM Press, Addison-Wesley, Los Angeles, CA, USA (August 12–17), SIGGRAPH 2001 course pack edition, 2001.

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#### REFEREED POSTER PRESENTATIONS

- [20] Ladda Thiamwong, Nahal Norouzi, and **Greg Welch**, “Poster: Fear of falling and eye movement behavior in young adults and older adults during walking: A case study,” in *39th Annual Southern Gerontological Society Meeting*, (Buford, GA USA), April 11–14 2018.
- [19] Dongsik Jo, Kangsoo Kim, **Greg Welch**, Woojin Jeon, Yongwan Kim, Ki-Hong Kim, Gerard Kim, “The Impact of Avatar-Owner Visual Similarity on Body Ownership in Immersive Virtual Reality,” ACM Symposium on Virtual Reality Software and Technology (VRST), November 8–10, Gothenburg, Sweden.
- [18] Myungho Lee, Gerd Bruder, and **Greg Welch**, “Exploring the effect of vibrotactile feedback through the floor on social presence in an immersive virtual environment,” Vision Sciences Society 2017.
- [17] Ryan Schubert, Gerd Bruder, and **Greg Welch**, “Mitigating perceptual error in synthetic animatronics using visual feature flow,” Vision Sciences Society 2017.
- [16] Richard Skarbez, **Greg Welch**, Frederick P. Brooks Jr., and Mary C. Whitton, “Coherence changes gaze behavior in virtual human interactions,” in *Proceedings of IEEE Virtual Reality 2017*, pp. 287–288, March 2017.
- [15] Salam Daher, Kangsoo Kim, Myungho Lee, Gerd Bruder, Ryan Schubert, Jeremy Bailenson, and **Greg Welch**, “Can social presence be contagious? Effects of social presence priming on interaction with virtual humans,” in *Proceedings of IEEE Symposium on 3D User Interfaces 2017*, (Los Angeles, CA), March 18–19 2017.
- [15] Kangsoo Kim, Ryan Schubert, and **Greg Welch**. Poster: Exploring the impact of environmental effects on social presence with a virtual human. In *Proceedings of the 16th International Conference on Intelligent Virtual Agents (IVA 2016)*, volume 10011, pages 470–474, Los Angeles, CA, September 20–23, 2016.

- [14] **Greg Welch**, Salam Daher, Jason Hochreiter and Laura Gonzalez. Interactive Rear-Projection Physical-Virtual Patient Simulators. Poster presented at the 22nd Medicine Meets Virtual Reality (NextMed / MMVR) conference, Los Angeles, CA, April 7–9, 2016.
- [13] Salam Daher and **Greg Welch**. Humanikins: Humanity Transfer to Physical Manikins. Poster presented at the 22nd Medicine Meets Virtual Reality (NextMed / MMVR) conference, Los Angeles, CA, April 7–9, 2016.
- [12] Salam Daher, Kangsoo Kim, Myungho Lee, Andrew Raij, Ryan Schubert, Jeremy Bailenson, and **Greg Welch**. Poster: Exploring social presence transfer in real-virtual human interaction. In *Proceedings of IEEE Virtual Reality 2016*, Greenville, SC, USA, March 19–23, 2016.
- [11] Salam Daher, Laura Gonzalez, **Greg Welch**. Preliminary Assessment of Neurologic Symptomatology Using an Interactive Physical-Virtual Head with Touch. Poster presented at the 17th International Meeting on Simulation in Healthcare (IMSH 2016), January 16–20, 2016.
- [10] Feng Zheng, Ryan Schubert, and **Greg Welch**, “A General Approach for Closed-Loop Registration in AR,” in *ISMAR '12: Proceedings of the Eleventh IEEE International Symposium on Mixed and Augmented Reality (ISMAR'12)*, (Atlanta, GA, USA), November 2012.
- [9] **Greg Welch**, Diego Rivera-Gutierrez, Peter Lincoln, Mary Whitton, Juan Cendan, David A. Chesnutt, Henry Fuchs, Ben Lok, and Rick Skarbez. Physical manifestations of virtual patients. Poster presented at the 12th International Meeting on Simulation in Healthcare (IMSH 2011), 2011.
- [8] Jinghe Zhang, **Greg Welch**, Gary Bishop, and Zhenyu Huang. Adaptive kalman filtering for robust power system state tracking. Poster presented at the DOE Applied Mathematics Program meeting, October 17–18 2011.
- [7] Brian Clipp, **Greg Welch**, Jan-Michael Frahm, and Marc Pollefeys. Structure from motion via a two-stage pipeline of extended kalman filters. Proceedings of the British Machine Vision Conference (BMVC 2007), September 10–13 2007.
- [6] Hua Yang and **Greg Welch**. Illumination Insensitive Model-Based 3D Object Tracking and Texture Refinement. In Proceedings of the Third International Symposium on 3D Data Processing, Visualization and Transmission (3DPVT 2006), The University of North Carolina at Chapel Hill, Chapel Hill, NC USA, June 14-16, 2006.
- [5] Ruigang Yang, Liang Wang, **Greg Welch**, and Marc Pollefeys. Stereovision on GPU. Poster presentation at the 2006 Workshop on Edge Computing Using New Commodity Architectures (EDGE 2006), May 23–24 (Chapel Hill, NC, USA).
- [4] **Greg Welch**, Hua Yang, Andrei State, Vincent Noel, Adrian Ilie, Ruigang Yang, Marc Pollefeys, and Henry Fuchs. GPU-Based View Synthesis Using an Orbital Reconstruction Frustum. Poster presentation at the 2006 Workshop on Edge Computing Using New Commodity Architectures (EDGE 2006), May 23–24 (Chapel Hill, NC, USA).
- [3] Adrian Ilie and **Greg Welch**. Ensuring Color Consistency Across Multiple Cameras. International Conference on Computer Vision (ICCV), October, 2005 (Beijing, China).
- [2] Bruce A. Cairns, **Greg Welch**, Adrian Ilie, Ruigang Yang, Kok-Lim Low, Anselmo Lastra, Henry Fuchs, and Anthony Meyer. Three Dimensional (3D) Acquisition and Display of Reality: The Potential for a ‘Holodeck’ in Trauma Surgery. Presented at *The American Association for the Surgery of Trauma 2003 Annual Meeting*.

- [1] Kok-Lim Low, **Greg Welch**, Anselmo Lastra, and Henry Fuchs. Life-sized projector-based dioramas: Spatially real and visually virtual. In *ACM SIGGRAPH 2001 Sketches and Applications*, August 2001.

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## TECHNICAL REPORTS

- [13] Tyler Johnson, Herman Towles, Andrei State, Fu-Che Wu, **Greg Welch**, Anselmo Lastra, and Henry Fuchs. A Projector-based Physical Sand Table for Tactical Planning and Review. Technical Report TR09-017, University of North Carolina at Chapel Hill, Department of Computer Science, 2009.
- [12] Ramesh Raskar, Kok-Lim Low and **Greg Welch**. Shader Lamps: Animating Real Objects with Image-Based Illumination. Technical Report TR00-027, University of North Carolina at Chapel Hill, Department of Computer Science, 2000.
- [11] Ruigang Yang and **Greg Welch**. Automatic Display Surface Estimation using Everyday Imagery. Technical Report TR00-015, University of North Carolina at Chapel Hill, Department of Computer Science, 2000.
- [10] Ramesh Raskar, Henry Fuchs, **Greg Welch**, Adam Lake, and Matt Cutts. 3D Talking Heads: Image Based Modeling at Interactive Rates Using Structured Light Projection. Technical Report TR98-017, University of North Carolina at Chapel Hill, Department of Computer Science, 1998.
- [9] **Greg Welch**. SCAAT: Incremental Tracking with Incomplete Information. Technical Report TR96-051, University of North Carolina at Chapel Hill, Department of Computer Science, 1996.
- [8] **Greg Welch** and Gary Bishop. One-Step-at-a-Time Tracking. Technical Report TR96-021, University of North Carolina at Chapel Hill, Department of Computer Science, 1996.
- [7] **Greg Welch**. Hybrid Self-tracker: An Inertial/Optical Hybrid Three-Dimensional Tracking System. Technical Report TR95-048, University of North Carolina at Chapel Hill, Department of Computer Science, 1995.
- [6] **Greg Welch** and Gary Bishop. An Introduction to the Kalman Filter. Technical Report TR95-041, University of North Carolina at Chapel Hill, Department of Computer Science, 1995. Cited over 8200 times according to Google Scholar as of 6 March 2018. Translated into Chinese (modern and traditional) by others.
- [5] **Greg Welch** VERSICOM: Versatile communications software. NASA Jet Propulsion Laboratory, July 13, 1989.
- [4] **Greg Welch** and James P. Williams. The easy chair: A microprocessor-controlled wheelchair for children with muscular disorders. Purdue University, E.E.T. 490/491 Senior Design Project, Final Report, May 1986.
- [3] **Greg Welch**. The infrared touch-pad. Purdue University, E.E.T. 421 Report, February 26, 1986.
- [2] **Greg Welch** and James P. Williams. The easy chair: A microprocessor-controlled wheelchair for children with muscular disorders. Purdue University, E.E.T. 490/491 Senior Design Project, Preliminary Report, December 1985.
- [1] James Williams and **Greg Welch**. The pressure sensitive touch-pad. Purdue University, E.E.T. 454 Project Report, April 30, 1985.



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 PATENTS

- U.S. #9,808,549, “System for Detecting Sterile Field Events and Related Methods,” with Arjun Nagendran, Jason Hochreiter, Laura Gonzalez, and Hassan Foroosh.
- U.S. #9,792,715, “Methods, Systems, and Computer Readable Media for Utilizing Synthetic Animatronics,” with Kurtis Keller, Andrei State, Henry Fuchs, and Ryan Schubert.
- U.S. #9,679,500, “Physical-Virtual Patient Bed,” with Karen Aroian, Steven Talbert, Kelly Allred, Patricia Weinstein, Arjun Nagendran, and Remo Pillat.
- U.S. #9,538,167, “Methods, Systems, and Computer Readable Media for Shader-Lamps Based Physical Avatars of Real and Virtual People,” with Henry Fuchs, Peter Lincoln, Andrew Nashel, and Andrei State.
- U.S. #8,849,408, “Methods for Electronic Directionality of Deep-Brain Stimulation,” with Richard Gilson and Nizam Razack.
- U.S. #7,068,274, “System and Method for Animating Real Objects With Projected Images,” with Kok-Lim Low and Ramesh Raskar.
- U.S. #6,930,681, “System and Method for Registering Multiple Images with Three-Dimensional Objects,” with Ramesh Raskar and Kok-Lim Low.
- U.S. #6,677,956, “Method for Cross-Fading Intensities of Multiple Images of a Scene for Seamless Reconstruction,” with Ramesh Raskar and Kok-Lim Low.
- U.S. #5,870,136, “Dynamic Generation of Imperceptible Structured Light for Tracking and Acquisition of Three Dimensional Scene Geometry and Surface Characteristics in Interactive Three Dimensional Computer Graphics Applications,” with Gary Bishop, Henry Fuchs, and Mark Livingston.

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 DISSERTATION

Title: SCAAT: Incremental Tracking with Incomplete Information  
 Date: October 1996  
 Advisor: Gary Bishop  
 Committee: Gary Bishop, Henry Fuchs, Leandra Vicci (née Vernon Chi), Anselmo Lastra, Russell Taylor, and John Poulton  
 PDF [http://www.cs.unc.edu/~welch/media/pdf/scaat\\_dissertation.pdf](http://www.cs.unc.edu/~welch/media/pdf/scaat_dissertation.pdf)

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 STUDENT ACTIVITIES

- President, UNC-Chapel Hill Computer Science Student Association, 1994–1995
- Graduated with *Highest Distinction* from Purdue University (among three-tenths of the baccalaureate graduates having the highest graduation indexes)
- *Outstanding Senior Design Project*, “The Easy Chair: A Microprocessor-Controlled Wheelchair for Children With Muscular Disorders,” E.T., Purdue University, 1986
- *Distinguished Student*, Purdue University, 1982–1986 (all semesters)
- Residence Hall Counselor, Purdue University, 1985–1986
- Tau Alpha Pi National Honor Society, Pi Alpha Chapter, 1986
- Golden Key National Honor Society, 1984
- Phi Eta Sigma National Honor Society, 1983

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 ACTIVE FUNDING

- Soar Technology, Inc., “A16-076 Augmented/Mixed Reality for Force-on-Force Combat Casualty Care Training- Phase 1 Option,” **Greg Welch** (PI). SoarTech PI: Glenn Taylor. \$6,000.00 for November 27, 2017–March 26, 2018.
- Soar Technology, Inc., “Handoffs for Joint Service Casualty Care (HJSCC),” Francisco Guido-Sanz (PI) and **Greg Welch** (Co-PI). SoarTech PI: Alyssa Tanaka. \$59,763.00 for November 15, 2017–June 14, 2018.
- Soar Technology, Inc., “Handoff Training for Combat Casualty Care (HTC3),” **Greg Welch** (PI), Francisco Guido-Sanz (Co-PI), and Gerd Bruder (Co-PI). SoarTech PI: Alyssa Tanaka. \$60,000.00 for December 17, 2017–July 17, 2018.
- SA Photonics, Inc., “Blended Reality Solution for Live, Virtual, and Constructive Field Training,” **Greg Welch** (PI) and Gerd Bruder (Co-PI). SoarTech PI: Michael Browne. \$31,000.00 for November 16, 2017–June 1, 2018.
- ONR grant for “Enhanced Perception and Cognition in Augmented Reality (EPiC AR),” **Greg Welch** (PI) and Gerd Bruder (Co-PI). Dr. Peter Squire, Program Manager. \$1,175,000.00 total for January 2018–December 2020.
- UCF Office of Research and Commercialization, Mentoring Program Award, “Fear of Falling in Older Adults,” Ladda Thiamwong (PI) and **Greg Welch** (Mentor), \$3,000, July 1, 2017–June 30, 2018.
- Lockheed Martin Corporation grant for “Improving Augmented Reality Technology,” Joseph LaViola (PI), **Greg Welch** (Co-PI), and Malcolm Butler (Co-PI), \$100,000, September 1, 2016–August 29, 2017.
- NSF grant (Award# 1564065) for “CHS: Medium: Physical-Virtual Patient Bed for Healthcare Training and Assessment,” **Greg Welch** (PI), Juan Cendan (Co-PI), and Laura Gonzalez (Co-PI), NSF PD: Laura M. Stanley (IIS CHS), \$894,431 for August 1, 2016–July 31, 2019
- ONR DURIP grant for “Transportable Human-Surrogate Interaction System (THuSIS),” **Greg Welch** (PI). Dr. Peter Squire, Program Manager. \$148,216 for September 15, 2016–March 14, 2017.
- REU Grant (Award# 1560302) for “REU Site: Research Experiences in the Internet of Things,” led by Damla Turgut (PI) and Yier Jin (Co-PI), **Greg Welch** (Investigator) et al. \$359,912.00 for June 2016–May 2019

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 PAST FUNDING

- ONR grant for “Human-Surrogate Interaction,” **Greg Welch** (PI) at UCF; and Jeremy Bailenson at Stanford University. Dr. Peter Squire, Program Manager. \$2,312,188 total for March 2014–December 2017.
- SoarTech/Department of the Army SBIR grant for “Combat Casualty Care Augmented Reality Intelligent Training System (C3ARESIS),” **Greg Welch** (UCF PI) and Frank Guido-Sanz (UCF), \$18,000 + \$6,000 option, July 1, 2016–December 31, 2016
- ONR DURIP grant for “A Testbed for Evaluating Human Surrogates for Live-Virtual Training,” **Greg Welch** (PI) and Arjun Nagendran (Co-PI). Dr. Peter Squire, Program Manager. \$178,437.
- ONR DURIP grant for “A Physical-Virtual Human-Robot Interaction System for Training, Education, and Rehabilitation,” **Greg Welch** (PI), Charlie Hughes (Co-PI), and Arjun Nagendran (Investigator). Dr. Peter Squire, Program Manager. \$268,598. July 2012–July 2014.

- ONR grant for “3D Display and Capture of Humans for Live-Virtual Training,” led by **Greg Welch** (PI) and Charlie Hughes (Co-PI) at UCF, Jeremy Bailenson at Stanford University, and Mel Slater at the University of Barcelona. Dr. Peter Squire, Program Manager. \$1,316,334 total for October 2011–September 2014.
- University of Central Florida, Major Research Equipment grant for “Comparative Evaluations of Display and Control Paradigms for Surrogate Humans,” **Greg Welch** and Charlie Hughes, \$57,500, February 2013–June 2013.
- University of Central Florida, Institute for Simulation & Training, Simulation for Healthcare Education and Learning Laboratory (SHELL) grant for “Simulating Subtle Clinical Changes and Realistic Conversation: Going Beyond Mannequins,” Kelly Allred (PI), Patricia Weinstein, **Greg Welch**, Steve Talbert, Erica Hoyt, Karen J. Aroian, Anne E. Norris, Mary Lou Sole, Susan K. Chase. \$125,000 in October 2012.
- DOE grant for “Advanced Kalman Filter for Real-Time Responsiveness in Complex Systems,” led by **Greg Welch** (PI) at UNC and Zhenyu Huang (PI) at the Pacific Northwest National Laboratory. \$320,502 total for September 2009–August 2013.
- ARA/DARPA contract for “ULTRA-Vis Phase 3: Sensor Fusion Methods/Software to Achieve Robust Pose Estimation,” **Greg Welch** (PI). Alberico Menozzi, TPOC (ARA). \$73,438 total for June 2012–June 2013.
- ONR grant for “3D Display and Capture of Humans for Live-Virtual Training,” led by **Greg Welch** (lead PI) and Henry Fuchs (PI) at UNC, and Amela Sadagic (PI) at the Naval Postgraduate School. Roy Stripling and Clarke Lethin, Program Managers. \$2.3M total for May 2009–September 2012. Welch led on the proposal and leads the subsequent research at UNC.
- NSF CRI:IAD grant for “Integrated Projector-Camera Modules for the Capture and Creation of Wide-Area Immersive Experiences,” led by Henry Fuchs (PI), **Greg Welch** (Co-PI), Leonard McMillan (Co-PI), Mary Whitton (Co-PI), and Svetlana Lazebnik (Co-PI). \$310K total for April 2008–March 2012. Welch led on the proposal at UNC.
- ONR contract for “Behavior Analysis and Synthesis for Intelligent Training (BASE-IT),” led by **Greg Welch** (PI) at UNC, Amela Sadagic (PI) at the Naval Postgraduate School, and Rakesh Kumar (PI) and Hui Cheng (Co-PI) at Sarnoff. Roy Stripling, Ph.D., Program Manager. \$2.2M total for February 2008–September 2011. Welch led on the proposal and leads the subsequent research at UNC.
- ONR SBIR Phase II contract for “Deployable Intelligent Projection Systems for Training,” led by Henry Fuchs (PI) and **Greg Welch** (PI), sub-contract from Renaissance Sciences Corporation (RSC), Jeff Clark, CEO, \$374,920 for March 2009–February 2011. Welch led on the proposal and leads the subsequent research at UNC.
- UNC-Chapel Hill “Scholarship, Creative Activity or Research in the Humanities and Fine Arts” led by Francesca Talenti (PI) and **Greg Welch** (Co-PI), \$10K for June 2009–May 2010.
- IARPA A-SpaceX contract for “Mockup Future Analyst Workspace (A-Desk),” led by **Greg Welch** (lead PI) and Henry Fuchs (PI). Jeff Morrison, Ph.D., Program Manager. \$260K for April 2008–December 2008. Welch led the proposal and the subsequent research at UNC.
- ONR SBIR contract for “Deployable Intelligent Projection Systems for Training,” led by **Greg Welch** (PI) at UNC and Karl Matias (PI) of Renaissance Sciences Corporation, sub-contract to UNC-Chapel Hill (Henry Fuchs, PI), \$80K for Phase 1, June 2007–September 2008. Welch led on the proposal and led the subsequent research at UNC.
- IARPA VACE contract for “3D Content Extraction from Video Streams,” led by Marc Pollefeys (PI) and **Greg Welch** (Co-PI), with Jan-Michael Frahm. Dan Aldridge, Program Manager. \$660K October 2006–September 2008.
- Cisco Systems grant for “Telepresence Wall: Research Exhibit,” with Henry Fuchs. \$439K for August 2007–July 2008. Welch co-led the proposal and the subsequent research at UNC.

- ONR STTR contract for “Deployable Intelligent Projection Systems for Training: Enhanced Integrated Pose Estimation Technologies,” led by **Greg Welch** (PI) at UNC and Karl Matias (PI) of Renaissance Sciences Corporation, sub-contract to UNC-Chapel Hill (Henry Fuchs, PI), \$70K for Phase 1, August 2007–February 2008. Welch led on the proposal and led the subsequent research at UNC.
- Cisco Systems grant for “Prototype for Two-station, Four-Person, Proper Eye-Gaze Telepresence System,” with Henry Fuchs. \$376K total for August 2006–July 2007. Welch co-led on the proposal and co-led the subsequent research at UNC.
- National Library of Medicine contract for “3D Telepresence for Medical Consultation” led by **Greg Welch** (lead PI) and Prof. Henry Fuchs (PI) at UNC, Prof. Bruce Cairns, M.D. (Co-PI) at UNC, Prof. Ketan Mayer-Patel (Co-PI) at UNC, and Prof. Diane Sonnenwald (Co-PI) at Göteborg University and the University College of Borås. \$2.5M total for October 2003–December 2007. Welch led on the proposal and led the subsequent research at UNC.
- ONR VIRTE contract for “Front-Projective Display For Virtual Environments: Phase 2,” with Henry Fuchs and Herman Towles. Dylan Schmorrow, Ph.D. CDR MSC USN, Program Manager. \$560K total for October 2004–December 2007.
- Office of Naval Research DURIP 2006 grant for “Computing for Real World Acquisition, Display and Immersive Training,” with Henry Fuchs and Marc Pollefeys. \$136K total.
- DARPA DSO contract for “Wide Area Visuals for a Simulator in a Box,” with Henry Fuchs and Herman Towles. Ralph Chatham, DARWARS Program Manager. \$1.2M total for 2003–2006.
- NSF ITR grant “Electronic Books for the Tele-Immersion Age: A New Paradigm for Teaching Surgical Procedures,” led by **Greg Welch** (PI) at UNC and Andy van Dam (PI) at Brown University, \$609K (UNC) for Sep 2001–Aug 2005. Welch led on the proposal and led the subsequent research at UNC.
- DOE contract “Front-Projection Display Wall, Group Tele-Immersion, and Tracking,” with Henry Fuchs and Herman Towles, \$1.8M for September 2001–August 2004.
- “3D Tele-Immersion Over Next Generation Internet,” UNC/UPenn DARPA contract with Henry Fuchs, Herman Towles, Kostas Danillidis, and Ruzena Bajcsy, \$550K (UNC) for June 2001–December 2002.
- Argonne National Laboratories contract “Compensating for Color Variations Across Multi-Projector Displays,” \$61K for September 2001–August 2002. Led by **Greg Welch** (PI).
- NSF grant “High-Fidelity Tele-Immersion for Advanced Surgical Training,” UNC/UPenn/Brown, with Henry Fuchs, Kostas Danillidis, and Andy van Dam, \$750K (UNC) for January 2001–December 2001.
- Naval Research Lab contract “Technology for Full-Body Tracking,” with Gary Bishop. Larry Rosenblum, NRL program manager. \$100,271 over October 2000–September 2001.
- NSF Research Infrastructure grant for the NSF Graphics and Visualization Science and Technology Center. The entire Center participated in the proposal process, **Greg Welch** played a significant role in the proposal content/realization. This grant supported equipment for Center-wide televideo and several related research projects. Support under this grant totaled \$1.3M for the Center over October 1998–September 2001. The UNC portion was \$304K.
- “The National Tele-Immersion Initiative,” with Henry Fuchs. Gift from Advanced Network and Services, Inc., Al Weiss, Terry Rogers, and Jaron Lanier. \$750K per year over January 1998–December 2000.
- NSF Graphics and Visualization Science and Technology Center, 5-year Renewal. The entire Center participated in the renewal proposal process, including a major site visit at the University of Utah, summer 1997. In addition to contributing to the written proposal, **Greg Welch** played a significant role in the Utah site visit. Total Center support under this renewal totals approximately \$13.7M for the entire Center for the final four years (February 1998–January

2002). The UNC portion totaled approximately \$2.7M over those four years.

- DARPA contract “Geospatially Registered Information for Dismounted Infantry” (GRIDS), with Gary Bishop and Vernon Chi. Joint effort with Raytheon Defense Systems, Hughes Research Labs, UNC, and the University of Southern California. Total support over two years (May 1997–April 1999) was approximately \$3.1M, UNC portion was approximately \$1.2M.

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**PROFESSIONAL EXPERIENCE****University of Central Florida, Orlando, Florida**

*Florida Hospital Endowed Chair in Healthcare Simulation*, October 2013–present

Professor, College of Nursing, October 2013–present

Professor, Computer Science Division of CECS, November 2013–present

Professor, Institute for Simulation & Training, November 2013–present

Co-Director, IST Synthetic Reality Lab (SREAL), August 2011–present

Co-Director, Interactive Computing Experiences Research Cluster of Excellence (2014–2017)

Research Professor, Institute for Simulation & Training (IST), August 2011–October 2013

Research Professor, Department of Computer Science, CECS, October 2011–October 2013

**University of North Carolina at Chapel Hill, Chapel Hill, North Carolina**

Adjunct Research Professor, Computer Science, September 2012–present

Research Professor, Computer Science, July 2010–August 2012

Research Associate Professor, Computer Science, September 2001–June 2010

Adjunct Associate Professor, Applied & Materials Sciences, 2005–2008

Adjunct Assistant Professor, Applied & Materials Sciences, 2000–2003

Research Assistant Professor, Computer Science, September 1996–August 2001

UNC Site Coordinator, NSF Graphics and Visualization STC, September 1996–August 1998

**University College Dublin (2011–2016)**

Visiting Professor, School of Information and Library Studies

**Keio University (2010–present)**

Visiting Professor, Graduate School of Media Design

**Renaissance Sciences Corporation, Chandler, Arizona**

Principal Investigator II, June 2007–2008

- Part-time research and development efforts related to “intelligent projector units” for deployable training systems.
- Work with Jeff Clark and Karl Mathias at RSC to coordinate UNC-RSC joint efforts.

**Northrop Defense Systems Division, Rolling Meadows, Illinois**

Senior Software Engineer, Digital Systems, June 1990–June 1992 (Secret Clearance)

- Developed, integrated, and maintained embedded software for the AN/ALQ-135, the electronic (radar) countermeasures system currently deployed on the USAF F-15 Eagle.
- Responsible for the AN/ALQ-135 Receiver-Transmitter Compatibility Feature which ensures that radar countermeasures do not interfere with radar or threat acquisitions.

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**PROFESSIONAL EXPERIENCE (CONTINUED)****NASA Jet Propulsion Laboratory (Caltech), Pasadena, California**

CCS/COMSIM Programmer and Analyst, Voyager Sequence Team, January 1987–May 1990

- Enhanced and maintained the software Command Simulator for the Voyager spacecraft. This simulator is (still) used to validate all instructions sent to the spacecraft.
- Programmed and maintained the Voyager spacecraft Computer Command Subsystem (CCS), the master processor on both Voyager spacecraft.
- Simulated and validated Voyager spacecraft command sequence activity. Responsible for the simulation and validation of all sequenced commanding during Voyager II closest approach to the planet Neptune.

Significant Projects (developed under own initiative)

- Developed MEMMAN, a ground-based software system that optimizes the allocation of the limited Voyager spacecraft memory. Savings during the Voyager II Neptune encounter (August, 1989) enabled additional planetary imaging.
- Developed specialized IBM PC/AT telecommunications software for the Voyager Flight Team. Software submitted to NASA for distribution under COSMIC. Still used today.

**Purdue University, West Lafayette, Indiana**

Undergraduate, Electrical Engineering Technology, August 1982–May 1986

- Co-developed “The Easy Chair: A Microprocessor-Controlled Wheelchair for Children With Muscular Disorders.” The wheelchair included an ultrasonic “bumper” system, a custom infrared touch-pad, motor controllers, and a user-programmable 8085-based control unit.
- The Easy Chair project was awarded *Outstanding Senior Design Project* by the Purdue University Department of Electrical Engineering Technology, May 1986.
- Residence Hall Counselor (Resident Assistant) at Cary Quadrangle, August 1985–May 1986.