

# Christopher R. Wren, Ph.D.

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## Experience

### Digital Services Expert

United States Digital Service, Remote

2021 – *present*, GS15, active Top Secret / SCI clearance

Rapid response software engineering, process engineering, data science, and engineering management for government projects in the immigration and social safety net domains, with a strong focus on improving the experience of the most vulnerable among us.

### Senior Staff Software Engineer

Google, Inc., Cambridge, MA, USA

2008 – 2021

Software and user experience analytics at global-scale: API design, user interface innovation on both mobile and the web, in social and mobile platform product contexts, as an individual contributor, technical lead, and engineering manager. Built collaborations across products and functions as a platform owner. Led cross-product, rapid-response engineering teams. Built and maintained geographically distributed teams. Internal and external public speaking. Launched many major product improvements and platforms. Numerous internal awards.

### Visiting Scientist

Massachusetts Institute of Technology. Cambridge, MA, USA

Media Laboratory, Human Dynamics Group

2017 – 2019

Mentorship and technology transfer. Topics included data privacy and digital contracts.

### Principal Research Scientist

Mitsubishi Electric Research Laboratories, Cambridge, MA, USA

Research Laboratory

2001 – 2008

Invention and prototyping of perceptual and context-aware systems for human interface and automation in the context of smart buildings, personal computing, and health care. Internal technology transfer, internal and external technical demonstrations and public speaking. Numerous patent disclosures and academic publications.

### Senior Perceptual Engineer

Perceptive Network Technologies, Inc., Waltham, MA, USA

2000 – 2001

Founding member, bringing perceptual technology to chat and video conferencing applications to create context-aware communication products. Full-stack Windows development from device interface and signal processing, to user interface design and implementation. Setting company technical culture and development processes.

### Research Assistant

Massachusetts Institute of Technology. Cambridge, MA, USA

Media Laboratory, Vision and Modeling Group

1994 – 2000

Invented and developed perceptual toolkits used internationally by many academic and research institutions. Statistical computer vision combined with techniques from control theory, embedded in systems with human-centered design principles. Demonstrations, often in collaboration with digital artists, and public speaking.

### Engineer and Dynamicist

Boston Dynamics Inc., Cambridge, MA, USA

1993 – 1994

Fifth employee. Built physics-based simulations, animation systems, and haptic interfaces for academic, industrial, and governmental clients, in a fast-paced consulting environment.

## Education

**Doctor of Philosophy**, Massachusetts Institute of Technology  
Department of Electrical Engineering and Computer Science  
Thesis Title: "Understanding Expressive Action."  
Minor: "Stochastics, Dynamics, and Recursive Filtering."

**Master of Science**, Massachusetts Institute of Technology  
Department of Electrical Engineering and Computer Science  
Thesis Title: "Pfinder: Real-Time Tracking of the Human Body"

**Bachelor of Science**, Massachusetts Institute of Technology  
Department of Electrical Engineering and Computer Science  
Minor: Cognitive Psychology.

**Secondary Education** Western Reserve Academy, Hudson, OH, USA

## Highlights

### **Operation Allies Welcome and Operation Allies Refuge at USDS:**

Part of a small, rapid-response team delivering software, data analysis, information visualization, and process optimization to facilitate the safe and speedy evacuation of U.S. allies and their loved ones out of Afghanistan, and their resettlement in the U.S. USDS Spot award and Department of Homeland Security challenge coin.

### **data-driven interface design for Android at Google:**

"Chris filled an enormous, dangerous void by addressing a very literal blind spot for Android. [His work] represents a landmark achievement in Android's history and a turning point in how we operate."

"It's impressive how much progress and thought leadership Chris has brought to [the project]."

### **mobile interface innovations:**

Android Notifications Technical Lead: shipping headline features in the Android System User Interface:

"Our favorite thing about [Android and Nexus]? Notifications. They're simply the best. They have essentially become the centerpiece of the device experience."

<https://www.wired.com/2014/10/hands-on-with-lollipop-and-nexus/>

### **rapid, Google-scale engineering in the social media product space::**

"Google+ Ripples Launch" Rapid design and implementation of an efficient, Google-scale share graph serving engine for the Google+ Ripples visualization.

[https://youtu.be/\\_j0I1a\\_Aw4g](https://youtu.be/_j0I1a_Aw4g)

### **best paper award at the top international information visualization conference:**

"Visualizing the History of Living Spaces" Yuri A. Ivanov, Christopher R. Wren, Alexander Sorokin, Ishwinder Kaur. IEEE Transactions on Visualization and Computer Graphics 13(6) pp 1153–1160. November 2007.

### **a publication with over 6,000 citations, according to Google Scholar:**

"Pfinder: Real-Time Tracking of the Human Body." Christopher R. Wren, Ali J. Azarbayejani, Trevor Darrell, and Alex P. Pentland. IEEE Trans. on Pattern Analysis and Machine Intelligence, 1997, 19(7), pp. 780-785.

## Hobbies

hiking, camping, board games, video games, geo-location games, 3D computer-aided design, 3D printing, embedded electronics, flying (active Private Pilot License), hanging out with my family and our pet rabbit

## Refereed Journal Papers and Chapters

“Visualizing the History of Living Spaces” Yuri A. Ivanov, Christopher R. Wren, Alexander Sorokin, Ishwinder Kaur. *IEEE Transactions on Visualization and Computer Graphics* 13(6) pp 1153–1160. November 2007.

“Functional Calibration for Pan-Tilt-Zoom Cameras in Hybrid Sensor Networks.” Christopher R. Wren, Murat Erdem, Ali J. Azarbayejani. *ACM Multimedia Systems Journal*, Special Issue on Multimedia Surveillance Systems. Online October 9, 2006. (updated version of MERL TR2005-084)

“Similarity-based analysis for large networks of ultra-low resolution sensors.” Christopher R. Wren, David Minnen, and Srinivas G. Rao *Pattern Recognition*, volume 39, issue 10, pp. 1918–1931. Special Issue on Similarity-Based Pattern Recognition. Elsevier. October 2006.

“Perception for Human Motion Understanding,” Christopher R. Wren in “Innovations in Machine Intelligence & Robot Perception” Vol. 7. Patnaik, Jain, Tzafestas, and Banoore (Eds.) Springer. 2005, IX. pp. 265–324.

“Minimalism in Ubiquitous Interface Design”, Christopher R. Wren and Carson J. Reynolds. *Personal and Ubiquitous Computing*, September 2004, 8(5), pp. 370-373.

“Perceptive Spaces for Performance and Entertainment: Untethered Interaction using Computer Vision and Audition.” Christopher R. Wren, Flavia Sparacino, Ali J. Azarbayejani, Trevor J. Darrell, Thad E. Starner, Akira Kotani, Chloe M. Chao, Michal Hlavac, Kenneth B. Russell, Alex P. Pentland. *Applied Artificial Intelligence*, June 1997, 11(4), pp. 267-284.

“Pfinder: Real-Time Tracking of the Human Body.” Christopher R. Wren, Ali J. Azarbayejani, Trevor Darrell, and Alex P. Pentland. *IEEE Trans. on Pattern Analysis and Machine Intelligence*, 1997, 19(7), pp. 780-785.

## Refereed and Invited Exhibitions

“Buzz: Measuring and Visualizing Conference Crowds” Christopher R. Wren, Yuri A. Ivanov, Darren Leigh, Jonathan Westhues, Mariela Buchin, Tai-Peng Tian, and Pavan Turaga. *ACM SIGGRAPH 2007 Emerging Technologies*, San Diego, CA, USA. August 2007.

“Ambient Intelligence for Better Buildings.” Yuri Ivanov, Christopher Wren, Darren Leigh, Jonathan Westhues, Alexander Sorokin, Ishwinder Kaur. *Demonstrations track of the 2006 Neural Information Processing Systems Conference*, Vancouver, Canada, December 4, 2006.

“Ambient Intelligence for Better Buildings.” Yuri Ivanov, Darren Leigh, Jonathan Westhues, Christopher R. Wren. *Mitsubishi Electric Internal Technology Roadshow*. Tokyo and Osaka, Japan. August 2006.

“Interacting With Projections Using iLamp Projectors.” Paul Beardsley, Shane Booth, Clifton Forlines, Ramesh Raskar, Jeroen Van Baar and Christopher R. Wren. *ACM SIGGRAPH 2004 Emerging Technologies*, Los Angeles, CA, USA. August 2004.

“Wearable City of News.” Flavia Sparacino, Steve Schwartz, Christopher R. Wren, Richard W. DeVaul, Gloriana Davenport, Alex P. Pentland. *ACM SIGGRAPH 1999 Millennium Motel*, Los Angeles, USA.

“Shall We Dance.” Kazuyuki Ebihara, Jun Ohya, Thanarat Horprasert, Ismail Haritaoglu, David Harwood, Larry S. Davis, Christopher R. Wren, Alex P. Pentland. *ACM SIGGRAPH 1998 Enhanced Realities*, Orlando, FL, USA. July 1998

“Toco the Toucan.” Deb Roy, Tony Jebara, Christopher R. Wren, William Tomlinson, Alex P. Pentland. *ACM SIGGRAPH 1997 Electric Garden*, Los Angeles, CA, USA. August 1997

“Smart Spaces.” Ali J. Azarbayejani, Christopher R. Wren, Andrew Wilson, David Becker, Nuria Oliver, Deb Roy, Flavia Sparacino, Francois Berard, Alex P. Pentland. *ACM SIGGRAPH 1996 Digital Bayou*, New Orleans, LA, USA. August 1996

“Dreams and Illusions.” Trevor Darrell, Bruce Blumberg, Michael P. Johnson, Christopher R. Wren, Pattie Maes, Alex P. Pentland. *ACM SIGGRAPH 1995*, Los Angeles, CA, USA. August 1995

“Trans-Atlantic SURVIVE.” Thad Starner, Kenneth Russell, Christopher R. Wren, Martin R. Friedman, Alex P. Pentland. *1994 Schools Lecture*, BT Laboratories, Martlesham, England, October 1994.

## Refereed Conference and Workshop Papers

“Google+ Ripples: A Native Visualization of Information Flow.” Fernanda Viegas, Martin Wattenberg, Jack Hebert, Geoffrey Borggaard, Alison Cichowlas, Jonathan Feinberg, Jon Orwant, and Chris Wren, Proceedings of the 22nd International World Wide Web Conference, May 2013. Rio de Janeiro, Brazil.

“Pokey: Interaction through covert structured light.” Christopher R. Wren, Yuri Ivanov, Paul Beardsley, Biliana Kaneva, and Shoji Tanaka, Third IEEE International Workshop on Horizontal Interactive Human Computer Systems (TABLETOP). October 2008. Amsterdam.

“Ambient Intelligence as the Bridge to the Future of Pervasive Computing” Christopher R. Wren, Yuri A. Ivanov. Eighth International Conference on Automatic Face and Gesture Recognition. September 2008. Amsterdam.

“Soda Pop Zombies: Soft Drink Consumption and Motion” Daniel Wigdor, Yuri A. Ivanov, Christopher R. Wren. Proceedings of the 2007 ICMI Workshop on Massive Datasets. Nov. 2007. Nagoya, Japan.

“SocialMotion: Measuring the Hidden Social Life of a Building” Christopher R. Wren, Yuri A. Ivanov, Ishwinder Kaur, Darren Leigh, Jonathan Westhues. Third International Symposium on Location- and Context-Awareness. September 2007. Oberpfaffenhofen, Germany.

“Tracking People in Mixed Modality Systems” Yuri Ivanov, Alexander Sorokin, Christopher Wren, Ishwinder Kaur. Visual Communications and Image Processing 2007. February 2007. San Jose, California.

“Toward Scalable Activity Recognition for Sensor Networks” Christopher R. Wren and Emmanuel Munguia Tapia. Second International Workshop on Location- and Context-Awareness. 10-11 May 2006. Dublin, Ireland.

“Worse is Better for Ambient Sensing” Carson J. Reynolds and Christopher R. Wren. Pervasive 2006 Workshop on Privacy, Trust and Identity Issues for Ambient Intelligence. May 7th, 2006. Dublin, Ireland.

“Toward Spatial Queries for Spatial Surveillance Tasks” Christopher R. Wren and Yuri A. Ivanov. Pervasive 2006 Workshop on Pervasive Technology Applied Real-World Experiences with RFID and Sensor Networks. May 7, 2006. Dublin, Ireland.

“Automatic Pan-Tilt-Zoom Calibration in the Presence of Hybrid Sensor Networks”, Christopher R. Wren, Murat Erdem, Ali J. Azarbayejani, Third ACM International Workshop on Video Surveillance and Sensor Networks, Singapore, November 11, 2005.

“Change Detection by Frequency Decomposition: Wave-Back”, Fatih Porikli, Christopher R. Wren. Workshop on Image Analysis for Multimedia Interactive Services, April 2005.

“Large Networks of Ultra-low Resolution Sensors in Buildings”, Christopher R. Wren. International Conference on Integration of Knowledge Intensive Multi-Agent Systems, pp. 373-389, April 2005

“Waviz: Spectral Similarity for Object Detection” Christopher R. Wren, Fatih Porikli. IEEE International Workshop on Performance Evaluation of Tracking and Surveillance. Breckenridge, CO, USA. January 2005.

“Interactive Projection” Paul Beardsley, Shane Booth, Clifton Forlines, Ramesh Raskar, Jeroen Van Baar and Christopher R. Wren. ACM SIGGRAPH 2004, Emerging Technologies, Los Angeles, CA, USA. August 2004.

“Finding Temporal Patterns by Data Decomposition.” David C. Minnen and Christopher R. Wren. IEEE International Conference on Automatic Face and Gesture Recognition, Seoul, Korea, May 2004.

“Self-configuring, Lightweight Sensor Networks for Ubiquitous Computing.” Christopher R. Wren and Srinivasa Rao. International Conference on Ubiquitous Computing, pp. 205-206, Seattle, WA, USA, September 2003.

“Parsimony & Transparency in Ubiquitous Interface Design.” Christopher R. Wren and Carson J. Reynolds. International Conference on Ubiquitous Computing, pp. 31-33, Göteborg, Sweden, September 2002.

“Browsing 3-D spaces with 3-D vision: body-driven navigation through the Internet City” Flavia Sparacino, Christopher R. Wren, Ali J. Azarbayejani, Alex P. Pentland. Proceedings of 3DPVT: 1st International Symposium on 3D Data Processing Visualization and Transmission, Padova, Italy, June 19-21 2002.

“Volumetric Operations with Surface Margins.” Christopher R. Wren, Yuri A. Ivanov. IEEE Computer Vision and Pattern Recognition Technical Sketches, Kauai, HI, December 2001.

“Combining Audio and Video in Perceptive Spaces.” Christopher R. Wren, Sumit Basu, Flavia Sparacino, Alex P. Pentland. First International Workshop on Managing Interaction, Dublin, Ireland, December 1999.

“Understanding Purposeful Human Motion.” Christopher R. Wren and Alex P. Pentland. 1999 IEEE International Workshop on Modeling People, Kerkyra, Greece, September 20, 1999

“City of News.” Flavia Sparacino, Richard DeVaul, Christopher R. Wren, Ronald MacNeil, Gloriana Davenport, Alex P. Pentland. SIGGRAPH 1999, Visual Proceedings, Los Angeles, CA, USA, August 8-13, 1999.

“Augmented Performance in Dance and Theater.” Flavia Sparacino, Christopher R. Wren, Glorianna Davenport, Alex P. Pentland. International Dance and Technology, Arizona State University, Feb. 25-28, 1999.

“Digital Circus: a computer-vision based interactive Virtual Studio.” Flavia Sparacino, Christopher R. Wren, Glorianna Davenport, Alex P. Pentland IMAGINA, Monte Carlo, Monaco, January 18-20 1999.

“Real-time 3D Motion Capture.” Thanarat Horprasert, Ismail Haritaoglu, David Harwood, Larry S. Davis, Christopher R. Wren, Alex P. Pentland. Workshop on Perceptual User Interfaces, San Francisco, CA, USA, November 4-6, 1998

“Dynamic Modeling of Human Motion.” Christopher R. Wren and Alex P. Pentland. Proceedings of the Third IEEE International Conference on Automatic Face and Gesture Recognition, Nara, Japan, April 14-16, 1998

“Perceptive Spaces: Learning Dynamic Models of Human Behavior.” Christopher R. Wren, Sumit Basu, Alex P. Pentland. Workshop on Perceptual User Interfaces, Banff, Canada, October 19-21, 1997

“Improvisational Theater Space.” Flavia Sparacino, Kristin Hall, Christopher R. Wren, Glorianna Davenport, and Alex P. Pentland. The Sixth Biennial Symposium for Arts and Technology, Connecticut College, New London, CT, USA, February 27 - March 2, 1997.

“Pfinder: Real-Time Tracking of the Human Body.” Christopher R. Wren, Ali J. Azarbayejani, Trevor Darrell, and Alex P. Pentland. Second IEEE International Conference on Automatic Face and Gesture Recognition, Killington, VT, USA, October 1996.

“Real-time 3-D Tracking of the Human Body.” Ali J. Azarbayejani, Christopher R. Wren, Alex P. Pentland. Proceedings of IMAGE'COM 96, Bordeaux, France, May 1996

“HyperPlex: a World of 3D Interactive Digital Movies.” Flavia Sparacino, Christopher R. Wren, Alex P. Pentland, Glorianna Davenport. Proc. of IJCAI'95 Workshop on Entertainment and AI/Alife. Montreal, Canada. pp. 77-81. August 1995.

### **Lectures, Workshops, and Tutorials**

“Respecting User Attention: Notification Best Practices” at the Android Developer Summit, Mountain View, California, November 2015.

<https://youtu.be/WzRSpZpw2wg>

“Android and You” TEDxBeaconStreet, Brookline, Massachusetts, November 2014.

<https://youtu.be/Wn7qWrMWlH8>

“Sensor Networks for Better Buildings” Google TechTalks, Mountain View, California, February 2007.

<https://youtu.be/OZd5IaN63CY>

“Using sensor networks for action recognition” Neural Information Processing Systems 2005 Workshop on Recognition and Discovery of Activities and Interactions. Whistler, British Columbia, Canada, December 2005.

“Activity Mining in Sensor Networks.” Neural Information Processing Systems 2004 Workshop on Activity Recognition and Discovery. Whistler, British Columbia, Canada, December 2004.

## Patents and Patent Applications

*Patents may also have been filed in Japan or Europe.*

- U.S. Patent 10,938,767 "Outputting reengagement alerts by a computing device"
- U.S. Patent 10,142,351 "Retrieving contact information based on image recognition, III"
- U.S. Patent 10,145,947 "Mapping positions of devices using audio II"
- U.S. Patent 9,753,129 "Mapping positions of devices using audio I"
- U.S. Patent 9,519,638 "Feed translation for a social network, III"
- U.S. Patent 9,454,665 "Retrieving contact information based on image recognition, II"
- U.S. Patent 9,449,302 "Generating personalized websites and newsletters"
- U.S. Patent 9,148,742 "Proximity detection via audio"
- U.S. Patent 9,137,194 "Tools for micro-communities, II"
- U.S. Patent 8,818,049 "Retrieving contact information based on image recognition, I"
- U.S. Patent 8,694,593 "Tools for micro-communities, I"
- U.S. Patent 8,694,445 "Triggering attract mode for devices, II"
- U.S. Patent 8,538,742 "Feed translation for a social network, II"
- U.S. Patent 8,533,266 "User presence detection and event discovery"
- U.S. Patent 8,510,381 "Sharing electronic resources with users of nearby devices"
- U.S. Patent 8,447,516 "Efficient proximity detection."
- U.S. Patent 8,412,512 "Feed translation for a social network, I"
- U.S. Patent 8,401,981 "Triggering attract mode for devices, I"
- U.S. Patent 8,149,278 "Modeling Movement with Probabilistic Graphs."
- U.S. Patent 7,907,781 "Determining Geometries of Scenes."
- U.S. Patent 7,667,730 "Composite Surveillance Camera System."
- U.S. Patent 7,619,647 "Context Aware Surveillance System Using a Hybrid Sensor Network."
- U.S. Patent 7,542,949 "Efficient Hierarchical Decomposition of Temporal Patterns."
- U.S. Patent 7,415,164 "Spectral Similarity for Object Detection."
- U.S. Patent 7,359,836 "Scalable Activity Recognition for Sensor Networks."
- U.S. Patent 7,302,369 "Traffic and Geometry Modeling with Sensor Networks."
- U.S. Patent 7,242,421 "Establishing a communications link by sensing perceptual presence."
- U.S. Patent 6,911,995 "Depth Segmentation with Virtual Surface Margins."
- U.S. Patent 6,680,745 "Videoconferencing method with tracking of face and dynamic bandwidth allocation."