# Heather Culbertson

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## Education

**Doctor of Philosophy**, Mechanical Engineering & Applied Mechanics — August 2015
*University of Pennsylvania*
Dissertation: Data-Driven Haptic Modeling and Rendering of Realistic Virtual Textured Surfaces
Advisor: Dr. Katherine J. Kuchenbecker

**Master of Science**, Mechanical Engineering & Applied Mechanics — May 2013
*University of Pennsylvania*

**Bachelor of Science with Distinction**, Mechanical Engineering — May 2010
*University of Nevada, Reno*
Summa Cum Laude
Minor: Mathematics
Graduation Award: Senior Scholar, the top graduate in the School of Engineering

## Positions Held

**WiSE Gabilan Assistant Professor** — January 2018-present
University of Southern California, Department of Computer Science
Courtesy Appointment, Dept. of Aerospace and Mechanical Engineering from Fall 2018

**Postdoctoral Research Fellow** — 2015-2017
Stanford University, Department of Mechanical Engineering
Advisor: Allison M. Okamura, Ph.D.

**Research and Teaching Assistant** — 2010-2015
University of Pennsylvania, Dept. of Mechanical Engineering and Applied Mechanics
Advisor: Katherine K. Kuchenbecker, Ph.D.

## Awards and Honors

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| Okawa Foundation Research Award | 2022 |
| IEEE Technical Committee on Haptics Early Career Award | 2021 |
| NSF CAREER Award | 2021 |
| Finalist for Best Paper, IEEE Haptics Symposium | 2020 |
| Best Paper, ACM Symposium on User Interface Software and Technology (UIST) | 2017 |
| Citation for Meritorious Service as a Reviewer, IEEE Transactions on Haptics | 2016 |
| Finalist for Best Poster, IEEE Haptics Symposium | 2014 |
| Best Hands-on Demonstration, IEEE World Haptics Conference | 2013 |
| Finalist for Best Paper, IEEE World Haptics Conference | 2013 |
| President Gutmann Leadership Award, University of Pennsylvania | 2013 |
| Finalist for Best Poster, IEEE Haptics Symposium | 2012 |
| National Science Foundation Graduate Research Fellowship | 2011 |
| Summa Cum Laude, University of Nevada | 2010 |
| Senior Scholar, University of Nevada (top engineering senior) | 2010 |
| Best Student Speech, Doc Harris Speech Competition, University of Nevada | 2009 |

## Publications

*Journal Articles*

[J1] Yang Chen, Kevin Oghalai, and **Heather Culbertson**, "Mitigating cybersickness during locomotion in VR through increased agency with vibrotactile feedback," *IEEE Transactions on Visualization and Computer Graphics (TVCG)*, Submitted, Under Review.

[J2] Xin Zhu, Tiantian Feng, and **Heather Culbertson**, "Understanding the effect of speed on human emotion perception in mediated social touch," *Frontiers in Computer Science*, Submitted, Under Review.

[J3] Naghmeh Zamani and **Heather Culbertson**, "Masking effects in combined hardness and stiffness rendering using an encountered-type haptic display," *IEEE Transactions on Haptics*, Submitted, Under Review.

[J4] Shihan Lu, Mianlun Zheng, Matthew C. Fontaine, Stefanos Nikolaidis, and **Heather Culbertson**, "Preference-driven texture modeling through interactive generation and search," *IEEE Transactions on Haptics*, Submitted, Under Revision.

[J5] Cara Nunez, Michael Raitor, Philipp J. Stolka, Allison M. Okamura, and **Heather Culbertson**, "Design and evaluation of haptic guidance in ultrasound-based needle-insertion procedures," *IEEE Transactions on Biomedical Engineering*, Submitted, Under Review.

[J6] Mike Salvato, Sophia Williams, Cara Nunez, Xin Zhu, Frances Lau, Keith Klumb, Ali Israr, Freddy Abnousi, Allison M. Okamura, and **Heather Culbertson**, "Data-driven sparse skin stimulation can convey social touch information to humans," accepted to *IEEE Transactions on Haptics*.

[J7] Shihan Lu, Yang Chen, and **Heather Culbertson**, "Towards multisensory perception: Modeling and rendering sounds of tool-surface interactions," *IEEE Transactions on Haptics (Impact Factor=2.757)*, 2020. doi:10.1109/TOH.2020.2966192

[J8] Pardis Miri, Andero Uusberg, Robert Flory, Agata Kelman, Erik Peper, Richard H. Harvey, **Heather Culbertson**, James Gross, Katherine Isbister, and Keith Marzullo, "PIV: Placement, pattern, and personalization of an inconspicuous vibrotactile breathing pacer," *ACM Transactions on Computer-Human Interaction*, vol. 27, no. 1, pp. 1–44, 2020. doi:10.1145/3365107

[J9] Cara M. Nunez, Sophia R. Williams, Allison M. Okamura, and **Heather Culbertson**, "Understanding continuous linear sensations from a sequential discrete lateral skin-slip haptic device," *IEEE Transactions on Haptics (Impact Factor=2.757)*, vol. 12, no. 4, pp. 414–427, 2019. doi:10.1109/TOH.2019.2941190

[J10] Peter B Shull, Tian Tan, **Heather Culbertson**, Xiangyang Zhu, and Allison Okamura, "Resonant frequency skin stretch for wearable haptics," *IEEE Transactions on Haptics (Impact Factor=2.757)*, vol. 12, no. 3, pp. 247–256, 2019. doi:10.1109/TOH.2019.2917072

[J11] Yuhang Che, **Heather Culbertson**, Chih-Wei Tang, Sudipto Aich, and Allison M Okamura, "Facilitating human-mobile robot communication via haptic feedback and gesture teleoperation," *ACM Transactions on Human-Robot Interaction (THRI)*, vol. 7, no. 3, p. 20, 2018. doi:10.1145/3243503

[J12] **Heather Culbertson**, Samuel B. Schorr, and Allison M. Okamura, "Haptics: The present and future of artificial touch sensations," *Annual Review of Control, Robotics, and Autonomous Systems*, 2018. doi:10.1146/annurev-control-060117-105043

[J13] Julie M. Walker, **Heather Culbertson**, Michael Raitor, and Allison M. Okamura, "Haptic orientation guidance using two parallel double-gimble control moment gyroscopes," *IEEE Transactions on Haptics (Impact Factor=2.000)*, 2017. doi:10.1109/TOH.2017.2713380

[J14] **Heather Culbertson** and Katherine Kuchenbecker, "Ungrounded haptic augmented reality system for displaying roughness and friction," *IEEE/ASME Transactions on Mechatronics (Impact Factor=4.357)*, 2017. doi:10.1109/TMECH.2017.2700467

[J15] **Heather Culbertson** and Katherine J. Kuchenbecker, "Importance of matching physical friction, hardness, and texture in creating realistic haptic virtual surfaces," *IEEE Transactions on Haptics (Impact Factor=2.000)*, vol. 10, no. 1, pp. 63–74, Jan.–March 2017. doi:10.1109/TOH.2016.2598751

[J16] **Heather Culbertson**, Juliette Unwin, and Katherine J. Kuchenbecker, "Modeling and rendering realistic textures from unconstrained tool-surface interactions," *IEEE Transactions on Haptics (Impact Factor=2.000)*, vol. 7, no. 3, pp. 381–393, July–Sept. 2014. doi:10.1109/TOH.2014.2316797

*Peer-Reviewed Conference Papers*

[C1] Naghmeh Zamani and **Heather Culbertson**, "Combining haptic augmented reality with encountered-type display to modify perceived hardness," in *IEEE Haptics Symposium*, 2022, accepted for publication.

[C2] Yawen Liu, Shihan Lu, and **Heather Culbertson**, "Texture classification by audio-tactile crossmodal congruence," in *IEEE Haptics Symposium*, 2022, accepted for publication.

[C3] Sunny Singh, Nitu Sharaff, Naghmeh Zamani, and **Heather Culbertson**, "Learning to feel: Predicting applied force from 2-d depth maps of object deformation," in *IEEE Haptics Symposium*, 2022, Submitted, Under Review.

[C4] Pardis Miri, Mehul Arora, Aman Malhotra, Robert Flory, Stephanie Hu, Ashley Lowber, Ishan Goyal, Jacqueline Nguyen, John P Hegarty II, Marlo Kohn, David Schneider, **Heather Culbertson**, Daniel L. K. Yamins, Lawrence Fung, Antonio Hardan James Gross, and Keith Marzullo, "FAR: End-to-end vibrotactile distributed system designed to facilitate affect regulation in children diagnosed with autism spectrum disorder through slow breathing," in *CHI Conference on Human Factors in Computing Systems*, 2022, Submitted, Under Review.

[C5] Naghmeh Zamani, Ashkan Pourkand, **Heather Culbertson**, and David Grow, "Plate-and-Cable (PAC) haptic device for orthopaedic training," in *International Symposium on Medical Robotics (ISMR)*, 2021.

[C6] Naghmeh Zamani, Pooja Moolchandani, Naomi Fitter, and **Heather Culbertson**, "Effects of motion parameters on acceptability of human-robot patting touch," in *Proc. IEEE Haptics Symposium*, 2020, pp. 664–670, (Acceptance Rate 48%). doi:10.1109/HAPTICS45997.2020.ras.HAP20.36.d8bb0c58

[C7] Dustin Goetz, David Owusu-Antwi, and **Heather Culbertson**, "PATCH: Pump Actuated Thermal Compression Haptics," in *Proc. IEEE Haptics Symposium*, 2020, pp. 643–649, (Acceptance Rate 48%). doi:10.1109/HAPTICS45997.2020.ras.HAP20.32.c4048ec3

[C8] Cara M. Nunez, Bryce N. Huerta, Allison M. Okamura, and **Heather Culbertson**, "SHIFTS: Social haptic interfaces for tactile stroking," in *Proc. IEEE Haptics Symposium*, 2020, pp. 629–636, (Acceptance Rate 48%). doi:10.1109/HAPTICS45997.2020.ras.HAP20.35.f631355d

[C9] Naghmeh Zamani and **Heather Culbertson**, "Effects of dental glove thickness on tactile perception through a tool," in *Proc. IEEE World Haptics Conference*, 2019, pp. 187–192, (Acceptance Rate=46%). doi:10.1109/WHC.2019.8816166

[C10] Weicheng Wu and **Heather Culbertson**, "Wearable haptic pneumatic device for creating the illusion of lateral motion on the arm," in *Proc. IEEE World Haptics Conference*, 2019, pp. 193–198, (Acceptance Rate=46%). doi:10.1109/WHC.2019.8816170

[C11] Nathaniel Agharese, Tyler Cloyd, Laura H. Blumenschein, Michael Raitor, Elliot W. Hawkes, **Heather Culbertson**, and Allison M. Okamura, "HapWRAP: Soft growing wearable haptic device," in *Proc. IEEE International Conference on Robotics and Automation (Acceptance Rate=40%)*, 2018, pp. 1–6. doi:10.1109/ICRA.2018.8460891

[C12] **Heather Culbertson**, Cara M. Nunez, Ali Israr, Frances Lau, Freddy Abnousi, and Allison M. Okamura, "A social haptic device to create continuous lateral motion using sequential normal indentation," in *Proc. IEEE Haptics Symposium*, 2018, pp. 32–39, (Acceptance Rate 40%). doi:10.1109/HAPTICS.2018.8357149

[C13] Inrak Choi, **Heather Culbertson**, Mark Miller, Alex Olwal, and Sean Follmer, "Grabity: A wearable haptic interface for simulating weight and grasping in virtual reality," in *Proc. ACM Symposium on User Interface Software and Technology*, 2017, pp. 119–130, (Acceptance Rate 23%), **Best Paper Award**. doi:10.1145/3126594.3126599

[C14] **Heather Culbertson**, Julie M Walker, Michael Raitor, and Allison M Okamura, "WAVES: A wearable asymmetric vibration excitation system for presenting three-dimensional translation and rotation cues," in *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, 2017, pp. 4972–4982, (Acceptance Rate 25%). doi:10.1145/3025453.3025741

[C15] Michael Raitor, Julie M Walker, Allison M Okamura, and **Heather Culbertson**, "WRAP: Wearable, restricted-aperture pneumatics for haptic guidance," in *Proc. IEEE International Conference on Robotics and Automation*, 2017, pp. 427–432, (Acceptance Rate 41%). doi:10.1109/ICRA.2017.7989055

[C16] **Heather Culbertson**, Julie M. Walker, Michael Raitor, Allison M. Okamura, and Philipp J. Stolka, "Plane assist: The influence of haptics on ultrasound-based needle guidance," in *Proc. International Conference on Medical Image Computing and Computer Aided Intervention (MICCAI)*. Springer, October 2016, pp. 370–377, (Acceptance Rate 30%). doi:10.1007/978-3-319-46720-7_43

[C17] **Heather Culbertson**, Julie M. Walker, and Allison M. Okamura, "Modeling and design of asymmetric vibrations to induce ungrounded pulling sensation through asymmetric skin displacement," in *Proc. IEEE Haptics Symposium*, April 2016, pp. 27–33, (Acceptance Rate 49%). doi:10.1109/HAPTICS.2016.7463151

[C18] Julie M. Walker, Michael Raitor, Alex Mallery, **Heather Culbertson**, and Allison M. Okamura, "A dual-flywheel ungrounded haptic feedback system provides single-axis moment pulses for clear direction signals," in *Proc. IEEE Haptics Symposium*, April 2016, pp. 7–13, (Acceptance Rate 49%). doi:10.1109/HAPTICS.2016.7463148

[C19] **Heather Culbertson** and Katherine J. Kuchenbecker, "Should haptic texture vibrations respond to user force and speed?" in *Proc. IEEE World Haptics Conference*, June 2015, pp. 106–112, (Acceptance Rate 42%). doi:10.1109/TOH.2016.2598751

[C20] **Heather Culbertson**, Juan José López Delgado, and Katherine J. Kuchenbecker, "One hundred data-driven haptic texture models and open-source methods for rendering on 3D objects," in *Proc. IEEE Haptics Symposium*, February 2014, pp. 319–325, (Acceptance Rate 68%), Finalist for Best Poster Award. doi:10.1109/HAPTICS.2014.6775475

[C21] **Heather Culbertson**, Juliette Unwin, Benjamin E. Goodman, and Katherine J. Kuchenbecker, "Generating haptic texture models from unconstrained tool-surface interactions," in *Proc. IEEE World Haptics Conference*, April 2013, pp. 295–300, (Acceptance Rate 59%), Finalist for Best Paper Award. doi:10.1109/WHC.2013.6548424

[C22] **Heather Culbertson**, Joseph M. Romano, Pablo Castillo, Max Mintz, and Katherine J. Kuchenbecker, "Refined methods for creating realistic haptic virtual textures from tool-mediated contact acceleration data," in *Proc. IEEE Haptics Symposium*, March 2012, pp. 385–391, (Acceptance Rate 61%), Finalist for Best Poster Award., doi = 10.1109/HAPTIC.2012.6183819.

*Short Peer-Reviewed Conference Papers and Abstracts*

[A1] Xin Zhu and **Heather Culbertson**, "Exploring emotion in mediated social touch with gesture parameters," in *Conference of the International Society for Research on Emotion*, Submitted, Under Review.

[A2] Naghmeh Zamani, Adim Abass, Manjunath Shetkar, Saumya Dureja, Menghan Li, **Heather Culbertson**, and James Finley, "Integrating haptic feedback into a virtual reality mobility training game for people with parkinson's disease," in *IEEE World Haptics Work-In-Progress*, 2021, pp. 1–2. doi:10.1109/WHC49131.2021.9517136

[A3] Rey Pocius, Naghmeh Zamani, **Heather Culbertson**, and Stefanos Nikolaidis, "Communicating robot goals via haptic feedback in manipulation tasks," in *ACM/IEEE HRI Pioneers Workshop*, 2020, pp. 591–593. doi:10.1145/3371382.3377444

[A4] David K. Owusu-Antwi, Weicheng Wu, and **Heather Culbertson**, "PATCH: Pump-actuated thermal compression haptics," in *IEEE World Haptics Work-In-Progress*, 2019.

[A5] Cara M. Nunez, Sophia R. Williams, Allison M. Okamura, and **Heather Culbertson**, "Continuous linear sensations from a sequential discrete lateral skin-slip haptic device," in *IEEE Haptics Symposium Work-In-Progress*, 2018.

[A6] Pardis Miri, Robert Flory, Andero Uusberg, **Heather Culbertson**, Helen Uusberg, James Gross, Keith Marzullo, and Katherine Isbister, "Emotion regulation in the wild: Introducing WEHAB system architecture," in *Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems*. ACM, 2018, p. LBW021. doi:10.1145/3170427.3188495

[A7] Karlin Bark, Ernest D. Gomez, Will McMahan, Charlotte Rivera, Austin Remington, **Heather Culbertson**, Kenric Murayama, David I. Lee, Kristoffel Dumon, Noel Williams, and Katherine J. Kuchenbecker, "Surgical instrument vibrations are a construct-valid measure of robotic technical skill for in vitro training tasks," June 2012, poster presentation at Symposium on Surgical Robotics.

*Textbook*

[T1] Maja Matarić, Nora Ayanian, Jeannette Bohg, **Heather Culbertson**, and Brenna Argall, *The Robotics Primer*. MIT Press, 2022.

*Open-Source Project*

[OS1] **Heather Culbertson**, Juan Jose Lopez Delgado, and Katherine J Kuchenbecker, "The Penn Haptic Texture Toolkit for modeling, rendering, and evaluating haptic virtual textures," February 2014. [Online]. Available: http://repository.upenn.edu/meam_papers/299/

*Hands-On Demonstrations*

[D1] Shihan Lu, Yang Chen, and **Heather Culbertson**, "A real-time sound modeling and rendering system for virtual tool-surface interactions," Hands-on Demonstration presented at *IEEE World Haptics Conference*, July 2021.

[D2] Xin Zhu, Tiantian Feng, and **Heather Culbertson**, "Wearable system for generating mediated social touch through force mapping," Hands-on Demonstration presented at *IEEE World Haptics Conference*, July 2021.

[D3] Eura Shin, Hejia Zhang, Rey J Pocius, Nathaniel Dennler, **Heather Culbertson**, Naghmeh Zamani, and Stefanos Nikolaidis, "Robot-assisted hair-brushing," Hands-on Demonstration presented at *Conference on Neural Information Processing Systems*, December 2019.

[D4] Pardis Miri, Andero Uusberg, Robert Flory, Agata Kelman, Erik Peper, Richard H. Harvey, **Heather Culbertson**, James Gross, Katherine Isbister, and Keith Marzullo, "Demonstrating personalization of PIV: Personalizable inconspicuous vibrotacile breathing paced," Hands-on Demonstration presented at *ACM CHI Conference on Human Factors in Computing Systems*, May 2019.

[D5] **Heather Culbertson**, Cara M. Nunez, and Allison M. Okamura, "Continuous lateral motion created using sequential normal indentation for displaying social haptic cues," Hands-on Demonstration presented at *IEEE Haptics Symposium*, San Francisco, CA, March 2018.

[D6] Michael Raitor, Matthew W. Gilbertson, Allison M. Okamura, and **Heather Culbertson**, "Wearable pneumatic wristband for displaying haptic guidance cues," Hands-on Demonstration presented at *IEEE World Haptics Conference*, Munich Germany, June 2017.

[D7] **Heather Culbertson**, Julie M. Walker, Michael Raitor, and Allison M. Okamura, "Targeting task using ungrounded pulling force induced by asymmetric vibrations," Hands-on Demonstration presented at *IEEE Haptics Symposium*, Philadelphia, Pennsylvania, April 2016.

[D8] Julie M. Walker, Michael Raitor, Alex Mallery, **Heather Culbertson**, Philipp J. Stolka, and Allison M. Okamura, "Moment pulses with a dual-flywheel ungrounded haptic feedback system," Hands-on Demonstration presented at *IEEE Haptics Symposium*, Philadelphia, Pennsylvania, April 2016.

[D9] **Heather Culbertson** and Katherine J. Kuchenbecker, "Haptic textures for online shopping." Interactive demonstrations in *The Retail Collective* exhibit, presented for two days at the *Dx3 Conference* in Toronto, Canada, March 2015.

[D10] **Heather Culbertson**, Juan José López Delgado, and Katherine J. Kuchenbecker, "The Penn Haptic Texture Toolkit," Hands-on Demonstration presented at *IEEE Haptics Symposium*, Houston, Texas, February 2014. doi:10.1109/HAPTICS.2014.6775540

[D11] **Heather Culbertson**, Craig G. McDonald, Benjamin E. Goodman, and Katherine J. Kuchenbecker, "Data-driven modeling and rendering of isotropic textures," Hands-on Demonstration presented at *IEEE World Haptics Conference*, Daejeon, South Korea, April 2013, Best Hands-On Demonstration Award.

[D12] Pablo Castillo, Joseph M. Romano, **Heather Culbertson**, Max Mintz, and Katherine J. Kuchenbecker, "Pen tablet drawing program with haptic textures," Hands-on Demonstration presented at *IEEE Haptics Symposium*, Vancouver, Canada, March 2012.

## Patents

[P1] Shihan Lu, **Heather Culbertson**, Matthew Fontaine, and Mianlun Zheng. *Interactive Texture Generation and Search System Driven by Human Preference.* United States Provisional Patent Application No. 63/184,659, filed May 6, 2021.

[P2] **Heather Culbertson**, Allison M. Okamura, Cara M. Nunez, and Sophia R. Williams. *Improved Haptic Devices to Create the Sensation of Continuous Lateral Motion.* United States patent pending under application PCT/US2019/022550, filed March 15, 2019.

[P3] Inrak Choi, Sean Follmer, and **Heather Culbertson**. *Grabity: A Virtual Reality Haptic Controller for Creating Gravity and Stiffness during Grasping Motions Through Asymmetric Vibrations.* United States patent US 10,852,872 B2, awarded December 1, 2020.

## Grants and Contracts

[G1] Okawa Foundation Research Grant
***Haptic Devices for Long-Distance Social Touch to Reduce Isolation***
Role: Principal Investigator — Co-PI: none
Sponsor: Okawa Foundation — Funding: $10,000
Dates: March 1, 2022 - February 28, 2023

[G2] NSF Grant #2051117
***REU Site: Robotics and Autonomous Systems***
Role: Co-Principal Investigator — PI: Stefanos Nikolaidis
Sponsor: National Science Foundation — Funding to HaRVI Lab: $3,000
Total Funding: $405,000
Dates: March 15, 2021 - February 29, 2024

[G3] NSF Grant #2047867
***CAREER: The Uncanny Valley in Socially Appropriate Haptic Interactions***
Role: Principal Investigator — Co-PI: none
Sponsor: National Science Foundation — Funding: $549,957
Dates: March 1, 2021 - February 28, 2026

[G4] NSF Grant #1929270
***3rd Summer School on Cognitive Robotics: Proposed Summer School***
Role: Principal Investigator — Co-PI: none
Sponsor: National Science Foundation — Funding: $11,232
Dates: June 1, 2019 - November 30, 2019

[G5] Subcontract from Facebook Research Contract
***Innatam - Approaches to Haptic Feedback for Social Touch***
Role: PI of USC Subcontract — PI at Stanford: Allison Okamura
Sponsor: Facebook, Inc. — Funding to USC: $98,548
Total funding: $948,000
Dates: January 1, 2018 - August 31, 2018

## Invited Talks

[T1] *Data-Driven Haptic Modeling.* Invited talk, IEEE World Haptics Conference. July 9, 2021.

[T2] *Haptic Modeling of Surfaces.* Invited talk, Cirrus Logic. July 1, 2021.

[T3] *Minimizing Hardware in Haptic Devices.* Invited talk, Materials and Mechanics Challenges in Haptics for Human-Machine Interfaces Symposium, Materials Research Society (MRS) Fall Meeting. December 2, 2020.

[T4] *Haptics for Commuinication in a Socially Distanced World.* Keynote lecture, Tactile Research Group Annual Meeting. November 19, 2020.

[T5] *Minimizing Haptic Hardware in Wearable Devices.* Invited talk, Intro to Haptics for XR tutorial, IROS 2020. October 29, 2020.

[T6] *Haptics for Communication in a Socially Distanced World.* Invited talk, Viterbi Live virtual seminar series, June 24, 2020.

[T7] *Fooling the Sense of Touch through Data and Illusions.* Invited talk, Workshop: Experiencing What's Not There, University of Toronto, June 7, 2019.

[T8] *Can You Feel It? Haptics for Realism and Virtual Communication.* Invited seminar, Department of Electrical and Computer Engineering, UCLA, April 29, 2019.

[T9] *Devices for Virtual Social Touch.* Invited talk, WiSE Horizons Research Symposium, University of Southern California, March 22, 2019.

[T10] *Virtual Social Communication Through Haptics.* Invited demo, Amazon MARS Conference, March 18-19, 2019.

[T11] *Haptic Perception and Technology.* Invited talk in CSCI 697: Seminar in Computer Science Research, Department of Computer Science, USC, February 25, 2019.

[T12] *Can You Feel It? Haptics for Realism and Virtual Communication.* Invited seminar, Department of Aerospace and Mechanical Engineering, USC, November 27, 2018.

[T13] *Haptics for Virtual Communication.* Invited AI seminar, Information Sciences Institute (ISI), USC, July 20, 2018.

[T14] *Haptics for Directional Guidance and Information Display in Cars.* Invited presentation and panel discussion. Peterson Automotive Museum, Los Angeles, California, April 28, 2018.

[T15] *Haptic Perception and Technology.* Invited talk in CSCI 697: Seminar in Computer Science Research, Department of Computer Science, USC, April 9, 2018.

[T16] *Realistic and Intuitive Haptic Feedback for Communication in Virtual and Real-World Environments.* Invited seminar, Worcester Polytechnic Institute, Worcester, Massachusetts, January 20; The Ohio State University, Columbus, Ohio, February 2; University of Southern California, Los Angeles, California, February 7; Carnegie Mellon University, Pittsburgh, Pennsylvania, February 13; University of Minnesota, Minneapolis, Minnesota, February 20; Arizona State University Polytechic Campus, Mesa, Arizona, February 23; University of Michigan, Ann Arbor, Michigan, March 8; École Polytechnique Fédérale de Lausanne (EPFL), March 13; University of California, Los Angeles, April 3, 2017.

[T17] *Haptics for Virtual and Real-World Applications.* University of California at Santa Barbara, Santa Barbara, California. December 2, 1016.

[T18] *Good Vibrations (and More): Haptics for Virtual Reality and Medicine.* Invited presentation, meeting of Technology and Society Committee, Mountain View, California. August 9, 2016.

[T19] *The Sense of Touch in Design.* Invited lecture, California College of the Arts, December 12, 2015.

[T20] *Data-Driven Modeling of Haptic Interactions for Virtual Reality.* Invited seminar, University of Nebraska, Lincoln, February 9; University of Maryland, College Park, March 3, 2015.

[T21] *Haptic Feedback for Natural User Interfaces.* Invited presentation with hands-on demonstrations presented jointly with Katherine J. Kuchenbecker, meeting of NUI Central, New York, New York. July 21, 2014.

[T22] *Modeling and Rendering of Virtual Haptic Textured Surfaces.* Seminar, Department of Mechanical Engineering and Applied Mechanics, University of Pennsylvania, Philadelphia, PA. July 15, 2014.

[T23] *Haptics: Making the Virtual World Feel Real.* Invited presentation, TEDxYouth @ Horseheads, New York. April 6, 2014.

[T24] *Haptic Rendering of Textures.* Half-day tutorial presented jointly with Katherine J. Kuchenbecker, IEEE Haptics Symposium, Houston, Texas. February 23, 2014.

## Media Highlights

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| December 2021 | Prof. Culbertson's research on social touch was featured in an article from Stanford University (Researchers create a device that imitates social touch, but from afar) |
| November 2021 | Prof. Culbertson was quoted in the book *Sticky: The Secret Science of Surfaces.* |
| May 2021 | HaRVI Lab undergraduate Alex Atcheson's research was featured on Viterbi website in article titled Computer Science Senior Creates Tech to Help Students with Visual Impairments Learn to Code. |
| April 2021 | Prof. Culbertson and her research was featured in the Viterbi magazine in a comic titled Virtual Touch in a Time of Isolation |
| June 2020 | The HaRVI Lab's Research was featured in the Viterbi Magazine in an article titled The Future at Your Fingertips. |
| February 2020 | Prof. Culbertson was featured in a Robohub podcast episode |
| March 2019 | Prof. Culbertson was quoted in an article published on Wired.com discussing the use of haptics for teleoperation (How I Became a Robot in London–From 5,000 Miles Away) |
| February 2019 | Article was published on ANA Travel Unlimited website quoting Prof. Culbertson and discussing research being done in HaRVI Lab (The 5 Biggest Tech Challenges to Building a Commercial Avatar) |
| December 2018 | Article was published in Knowable Magazine quoting Prof. Culbertson and discussing research being done in HaRVI Lab (Reaching Out to Touch Virtual Reality) |
| September 2018 | Article was published on Venture Beat focusing on research conducted in HaRVI Lab (Haptic Armband Lets You Feel the Sensation of Stroking in VR). |
| June 2018 | Research from HaRVI Lab was featured in article on Viterbi website titled USC Computer Science Professor Develops Haptic Armband to Mimic Human Touch. |
| May 2018 | Prof. Culbertson was quoted in an article in WIRED on additional senses for robots titled Give the Robots Electronic Tongues. |

May 2016 The New Yorker published a long article by Adam Gopnick featuring Prof. Culbertson and her research: Feel Me: What the New Science of Touch Says about Ourselves.

## Instruction and Course Development

**Introduction to Robotics.** This senior-level lecture and lab course presents the fundamental control, sensing, and planning principles underlying most modern robotic systems. The main topics include sensors, hardware, feedback control, odometry, mapping, planning, manipulation, multirobot systems, and haptics. The material is reinforced with weekly hands-on labs with mobile robots. *CSCI 445: 33 students in Fall 2021, 27 students in Fall 2020, 30 students in Spring 2020, 29 students in Spring 2019, 31 students in Spring 2018.*

**Haptic Interfaces and Virtual Environments.** This graduate-level course provides an introduction to the field of haptics, which involves human interaction with real, remote, and virtual objects through the sense of touch. Topics for the course include human haptic sensing and control, haptic interface design, virtual environment rendering methods, teleoperation control algorithms, and system evaluation. Coursework includes homework/laboratory assignments and a research-oriented project. *CSCI 699: 13 students in Fall 2019.*

**Assorted Other Topics (as a teaching assistant)** I worked as a teaching assistant for three semesters at the University of Pennsylvania. The courses I helped to teach were Introduction to Mechanics (MEAM 110), Introduction to Mechanics Lab (MEAM 147), and Analytical Methods for Engineers (ENM 251).

## Professional Service

**Conference and Workshop Organization:**

- *2021-present* Student Outreach, Smart Haptics Conference, San Diego, CA, 2022.
- *2020-present* Publications Chair, IEEE Haptics Symposium, Santa Barbara, CA, 2022.
- *2019-present* Student Innovation Challenge Chair, IEEE World Haptics Conference, Montreal, Canada, 2021.
- *2018-present* Work-in-Progress Chair, IEEE Haptics Symposium, Washington DC, 2020.
- *2018-present* Co-Organizer, Summer School on Cognitive Robotics, held at USC July 2019.
- *2019* Work-in-Progress Program Committee, World Haptics Conference, Tokyo, Japan, 2019.
- *2017-2018* Local Arrangements Chair, IEEE Haptics Symposium, San Francisco, California, March 2018.
- *2018* Program Committee, EuroHaptics Conference, Pisa, Italy, June 2018.
- *2018* Co-Organizer, Gendered Innovations Workshop on Gender in Robotics Research, Stanford, CA, January 2018.
- *2016* Video Chair, IEEE Haptics Symposium, Philadelphia, Pennsylvania, April 2016.

**Leadership Roles:**

*2018-present* Vice Chair for Information Dissemination, IEEE Technical Committee on Haptics.

**Reviews:**

*Associate Editor:*

- ACM Transactions on Human-Robot Interaction.
- CHI Conference on Human Factors in Computing Systems (Subcommittee: Building Devices–Hardware, Materials, and Fabrication)

*Journal paper reviewing:* IEEE Transactions on Haptics, IEEE Transactions on Applied Perception, IEEE Robotics and Automation Letters (RA-L), Proceedings of the IEEE, PLoS ONE, International Journal of Human-Computer Interaction, International Journal of Advanced Robotic Systems, The Visual Computer (TVCJ), Frontiers in Psychology, Frontiers in Pain Research.

*Conference paper reviewing:* IEEE Haptics Symposium, IEEE World Haptics Conference (WHC), EuroHaptics, IEEE International Conference on Robotics and Automation (ICRA), IEEE Conference on Virtual Reality and 3D User Interfaces (IEEE VR), ACM/IEEE International Conference on Human-Robot Interaction (HRI), ACM Conference on Human Factors in Computing Systems (CHI), ACM User Interface Software and Technology Symposium (UIST), ACM Symposium on Virtual Reality Software and Technology (VRST), ACM International Conference on Tangible, Embedded, and Embodied Interaction (TEI), International Conference on Humanoid Robots (Humanoids), IEEE/AT-EQUAL Conference on Human Machine System Cyborgs and Enhancing Devices (HUMASCEND).

*Grant proposal reviewing:*

- Two NSF Panels in 2021
- Two ad-hoc NSF proposal reviews in 2019
- External reviewer Mitacs Accelerate research proposal in 2019

## University Service

- Engineering Faculty Council (EFC) (2020-present).
- Viterbi Research Restart Committee (Summer 2020-present).
- Computer Science Department robotics hiring committee chair (2019-2020).
- Robotics PhD Committee (2018-present).
- Viterbi Research Committee (VRC) (2019-present).
- Computer Science Distinguished Lectures and Colloquium Series Co-Chair (2019-present).
- Aerospace and Mechanical Engineering Department robotics faculty hiring committee (2019).
- Graduate Admissions and Fellowship Committee (2018-2020).

## Scientific and Professional Societies

Institute for Electrical and Electronic Engineers (IEEE), Robotics and Automation Society, IEEE Women in Engineering

Association of Computing Machinery (ACM)

Society of Women Engineers (SWE)

Association for Women in Science (AWIS)

## Educational and Outreach Activities

- *Applying to Graduate School.* Presentation to summer undergraduate researchers, University of Southern California. June 18, 2021.
- *USC Makers.* Design review for undergraduate makers club, University of Southern California. March 19, 2021.
- *Haptics for Realism and Virtual Communication.* Research presentation to ACM student chapter, University of Southern California. October 27, 2020.
- *Handling Academic Criticism.* Presentation and panel to Women in Computing Club (WinCC), University of Southern California. October 9, 2020.
- *Alliance of Women in Media Arts and Sciences (AWMAS).* Research presentation at workshop for female graduate students, UC Santa Barbara. February 7, 2020.
- *Hidden No More.* Lab tour to visiting international women scientists, organized by U.S. Department of State. November 12, 2019.
- *Explore USC.* Lunch with parents of prospective undergrads, Unversity of Southern California. April 18, 2019.
- *Explore USC.* Research presentations to prospective undergrads, University of Southern California. April 16 and 23, 2019.
- *USC Robotics Open House.* Hands-on research demonstrations to local K-12 students, University of Southern California. April 10, 2019.
- *Engineering Diversity.* Lunch and panel with underrepresented minority students, University of Southern California, March 28, 2019.
- *Viterbi Summer Institute Panel.* Panel for incoming underrepresented Viterbi Freshman, University of Southern California. July 26, 2018.
- *Women Who Code Panel.* Panel for high school students in Girls Who Code program, University of Southern California. July 12, 2018. https://viterbipk12.usc.edu/2018/07/women-who-code/
- *USC Robotics Open House.* Research presentations to local K-12 students, University of Southern California. April 11, 2018.

## Advising

*Current Doctoral Students*

- Yang Chen, Computer Science, Summer 2020–present.
- Sandeep Kollannur, Computer Science, Annenberg Graduate Fellowship, Fall 2019–present.
- Shihan Lu, Computer Science (Quals passed September 27, 2021), Fall 2018–present.
- Catherine Yunis, Biomedical Engineering, Co-advised with James Finley, Fall 2019–present.
- Naghmeh Zamani, Computer Science, Annenberg Graduate Fellowship, Summer 2018–present.
- Xin Zhu, Computer Science, Annenberg Graduate Fellowship, Summer 2019–present.

*Current Masters Students*

- Hassan Hamod, Computer Science, Fall 2021–present.
- Pranavi Jalapati, Computer Science, Fall 2021–present.

- Shihong Ling, Computer Science, Spring 2021–present.
- Satya Naraparaju, Computer Science, Fall 2021–present.

*Current Undergraduate Students*

- Gabriel Benitez, Biomedical Engineering (CURVE Research Fellowship), Summer 2021–present.
- Zixin (Ellen) Ding, Computer Science, Fall 2021–present.
- Cami Gomez, Electrical and Computer Engineering, Summer 2021–present.
- Fred Liu, Computer Engineering and Computer Science, Fall 2021–present.
- Yawen Liu, Electrical Engineering, Summer 2020–present.
- Laya Madulapally, Computer Engineering and Computer Science, Fall 2021–present.
- Anish Nagareddy, Computer Science, Fall 2021–present.
- Huong Nguyen, Computer Science (CURVE Research Fellowship), Fall 2021–present.
- Kevin Oghalai, Electrical and Mechanical Engineering, Summer 2021–present.
- Victoria Pinkett, Mechanical Engineering (Viterbi Merit Research Award), Fall 2021–present.
- Scott Susanto, Computer Science, Fall 2021–present.
- Leo Zhuang, Computer Engineering and Computer Science, Fall 2021–present.
- Zuoning Zhang, Computer Engineering and Computer Science, Fall 2021–present.

*Former Masters Students*

- Kevin Figueroa, Computer Science (now a PhD student at University of Arizona), Summer 2020.
- Sunny Singh, Computer Science, **Viterbi Best MS Research Award** (now at Amazon), Fall 2019–Fall 2020.
- Reshu Bisht, Computer Science (now at Amazon), Fall 2019.
- Mansi Jaitly, Computer Science (now at Amazon), Spring 2019–Fall 2019.
- Shehadeh Dajani (now at Triple Ring Technologies), Mechanical Engineering, Summer 2018.
- Weicheng (Jerry) Wu, Mechanical Engineering, Summer 2018–Fall 2019.
- Xin Zhu, Computer Science, Began Summer 2018, continue to PhD.
- Nitu Sharaff, Computer Science (now at VMware Inc.), Spring 2018–Spring 2019.

*Former Undergraduate Students*

- Grace Owen, Biomedical Engineering at Case Western Reserve University (SURE), Summer 2021.
- Frank Peng, Computer Science, Spring 2021.
- Christopher Slaughter, Computer Engineering at University of Maryland-Baltimore County (REU), Summer 2020.
- Carlos Souffrain, Computer Engineering at University of Maryland-Baltimore County (REU), Summer 2020.
- Evelyn (Yifan) Zhuang, Computer Science, Spring 2020–2021.
- Brian Gillespie, Computer Science, Spring 2020–Summer 2021.
- Emiliia Dyrenkova, Computer Science at MiraCosta College (SURE), Summer 2019.
- Dustin Goetz, Mechanical Engineering at The Ohio State University (Awarded NSF Graduate Research Fellowship, now PhD student at UCSB), Summer 2019.
- M'Kya Williams, Computer Science Westmont College (REU), Summer 2019.
- Yang Chen, Computer Science (continued to PhD), Spring 2019–Fall 2020.
- Grant Garcia, Electrical Engineering, Spring 2019–Fall 2019.

- Samuel (Alex) Atcheson, Computer Engineering and Computer Science (Bridge Undergraduate Science Research Fellowship, Provost's Research Fellowship) (now PhD student at UIUC), **Outstanding CS Undergraduate Research Award**, Spring 2019–Summer 2021.
- Kivilcim Cumbul, Computer Engineering and Computer Science (WISE Undergraduate Research Fellowship, Provost's Research Fellowship), Spring 2019–Fall 2019.
- Nina Cragg, Arts Technology and the Business of Innovation, Spring 2019.
- Lawrence Park, Mechanical Engineering (now at Northrupp Grumman), Spring 2019.
- Josh Joseph, Computer Science, Fall 2018.
- David Owusu-Antwi, Physics MIT (NSF GRFP Honorable Mention) (now PhD student at University of Chicago), Summer 2018.
- Pooja Moolchandani, Computer Science (Now a PhD student in Robotics at Georgia Tech), Spring 2018–Sprint 2019.

*Former High School Students*

- Saamarth Sethi, Rising Sophomore, Whitney High School, Summer 2021.
- Smriti Wadha, Rising Senior, Arcadia High School, Summer 2021.
- Jesse Chen, Rising Junior, Mission San Jose High School, Summer 2020.
- Rachel Lobl, Rising Senior, San Marin High School, Summer 2019.

*Thesis Committees*

- Dario Urbina Melendez, Biomedical Engineering, (advised by Francisco Valero-Cuevas)
- Negin Heravi, Mechanical Engineering, (Stanford University, advised by Allison Okamura and Jeannette Bohg)
- Elizabeth Boronson, Computer Science (advised by Nora Ayanian)
- Ahmad Babaeian Jelodar, Computer Science and Engineering (University of South Florida, advised by Yu Sun), June 2021
- Shantanu Thakar, Mechanical Engineering (advised by S.K. Gupta), April 2021
- Brian Cohn, Computer Science (advised by Francisco Valero-Cuevas), May 2020
- Artem Molchanov, Computer Science (advised by Gaurav Sukhatme), May 2020
- Giovanni Sutanto, Computer Science (advised by Gaurav Sukhatme), April 2020
- Zaoyuan (Joey) Ge, Mechanical Engineering (advised by Nestor Perez-Arancibia), January 2020
- Yevgen Chebotar, Computer Science (advised by Gaurav Sukhatme), February 2019
- Zhe (Harry) Su, Computer Science (advised by Stefan Schaal), August 2018

*Qualifying Exam Committees*

- David Millard, Computer Science (advised by Gaurav Sukhatme), November 2021
- Nathan Dennler, Computer Science (advised by Maja Mataric), November 2021
- Dario Urbina Melendez, Biomedical Engineering (advised by Francisco Valero-Cuevas), August 2021
- K.R. Zentner, Computer Science (advised by Gaurav Sukhatme), July 2021
- Powen Yao, Computer Science (advised by Mike Zyda), June 2021
- Jingyao Ren, Computer Science (advised by Nora Ayanian), May 2021
- Mianlun Zheng, Computer Science (advised by Jernej Barbic), April 2021
- Chris Denniston, Computer Science (advised by Gaurav Sukhatme), January 2021
- Jason Gregory, Mechanical Engineering (advised by S.K. Gupta), July 2020
- Ke Xu, Mechanical Engineering (advised by Nestor Perez-Arancibia), July 2020

- Sarah Al-Hussaini, Computer Science (advised by S.K. Gupta), May 2020
- Mark Hermes, Mechanical Engineering (advised by Mitul Luhar), April 2020
- Brian Cohn, Computer Science (advised by Francisco Valero-Cuevas), December 2019
- Shantanu Thakar, Mechanical Engineering (advised by S.K. Gupta), August 2019
- Elizabeth Boroson, Computer Science (advised by Nora Ayanian), May 2019
- James Preiss, Computer Science (advised by Gaurav Sukhatme), April 2019
- Giovanni Sutanto, Computer Science (advised by Gaurav Sukhatme), April 2019
- Ryan Julian, Computer Science (advised by Gaurav Sukhatme), March 2019
- Zaoyuan (Joey) Ge, Mechanical Engineering (advised by Nestor Perez-Arancibia), January 2019
- Bohan Wang, Computer Science (advised by Jernej Barbic), November 2018
- Artem Molchanov, Computer Science (advised by Gaurav Sukhatme), May 2018
- Zhe (Harry) Su, Computer Science (advised by Stefan Schaal), April 2018
- Yevgen Chebotar, Computer Science (advised by Stefan Schaal), March 2018
- Liz Cha, Computer Science (advised byf Maja Mataric), December 2017