CS59200 Human-Robot Interaction

Instructor: Sooyeon Jeong, Assistant Professor of Computer Science
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Lecture: 9-10:15am Tue/Thu @ LWSN B134
Office Hours: TBD @ TBD
Instructional Modality: Face-to-Face
Course Credits: 3.0
Prerequisites: There are no prerequisites but backgrounds in robotics or human-computer interaction is encouraged. Programming knowledge may be useful for completing a course project.
Textbooks: No textbooks are required for this course.

Course Description

Robots are making their way into our world and will soon interact with people in our everyday lives. In order for robots to perform various supportive tasks and harmoniously coexist with people in human environments (e.g., homes, schools, and hospitals), they need to be designed and developed to interface with people in natural and intuitive ways. The field of Human-Robot Interaction (HRI) is highly interdisciplinary, incorporating methods and techniques from human-computer interaction, robotics, psychology, artificial intelligence, and other fields.

Students in the class will present assigned research papers and lead discussions about cutting-edge peer-reviewed HRI publications. Throughout the term, students will form small groups of teams and will complete a course project that addresses an HRI-related research question of their choice.

Learning Outcomes

After successfully completing this course, a student will learn a broad range of research topics in HRI for designing and developing a robot that can successfully interact with humans, including non-verbal/verbal robot behavior, learning and collaborating with humans, group interactions, and ethical considerations and challenges. Students will also learn how to conduct a scientifically rigorous human-subject research to test for HRI-related research questions and hypotheses, and how HRI research is currently applied in real world applications.

Course Schedule

Date	Topic	Readings and Assignment
8/22 Tue	Introduction to Human-Robot Interaction	Goodrich, M. A., & Schultz, A. C. (2008). Human–robot interaction: a survey. *Foundations and Trends® in Human–Computer Interaction*, *1*(3), 203-275. (Chapter 1-5)
8/24 Thu	Social Robot	[1] Breazeal, C., & Scassellati, B. (1999, October). How to build robots that make friends and influence people. In *Proceedings 1999 IEEE/RSJ international conference on intelligent robots and systems. Human and environment*

		friendly robots with high intelligence and emotional quotients (cat. No. 99CH36289) (Vol. 2, pp. 858-863). IEEE. [2] Matarić, M. J., & Scassellati, B. (2016). Socially assistive robotics. *Springer handbook of robotics*, 1973-1994.
8/29 Tue	Human-subject Research and Ethics	[1] Turkle, S., Taggart, W., Kidd, C. D., & Dasté, O. (2006). Relational artifacts with children and elders: the complexities of cybercompanionship. *Connection Science*, *18*(4), 347-361. [2] Kahn Jr, P. H., Kanda, T., Ishiguro, H., Freier, N. G., Severson, R. L., Gill, B. T., ... & Shen, S. (2012). "Robovie, you'll have to go into the closet now": Children's social and moral relationships with a humanoid robot. Developmental psychology, 48(2), 303.
8/31 Thu	Embodiment	[1] Bainbridge, W. A., Hart, J. W., Kim, E. S., & Scassellati, B. (2011). The benefits of interactions with physically present robots over video-displayed agents. *International Journal of Social Robotics*, *3*, 41-52. [2] Kidd, C. D., & Breazeal, C. (2008, September). Robots at home: Understanding long-term human-robot interaction. In *2008 IEEE/RSJ International Conference on Intelligent Robots and Systems* (pp. 3230-3235). IEEE. * **Complete Purdue's CITI Human Subjects Research certification**
9/5 Tue	Robot Morphology	[1] Mori, M., MacDorman, K. F., & Kageki, N. (2012). The uncanny valley [from the field]. *IEEE Robotics & automation magazine*, *19*(2), 98-100. [2] Sakamoto, D., Kanda, T., Ono, T., Ishiguro, H., & Hagita, N. (2007, March). Android as a telecommunication medium with a human-like presence. In *Proceedings of the ACM/IEEE international conference on Human-robot interaction* (pp. 193-200). [3] Breazeal, C., Siegel, M., Berlin, M., Gray, J., Grupen, R., Deegan, P., ... & McBean, J. (2008). Mobile, dexterous, social robots for mobile manipulation and human-robot interaction. In *ACM SIGGRAPH 2008 new tech demos* (pp. 1-1).
9/7 Thu	Robot Morphology	[1] Sirkin, D., Mok, B., Yang, S., & Ju, W. (2015, March). Mechanical ottoman: how robotic furniture offers and withdraws support. In *Proceedings of the Tenth Annual ACM/IEEE International Conference on Human-Robot Interaction* (pp. 11-18). [2] Hoffman, G., & Vanunu, K. (2013, March). Effects of robotic companionship on music enjoyment and agent perception. In *2013 8th ACM/IEEE International Conference on Human-Robot Interaction (HRI)* (pp. 317-324). IEEE.
9/12 Tue	Robot Movement and Gesture	[1] J. Lasseter, "Principles of Traditional Animation applied to 3D Computer Animation", in Computer Graphics, 1987. [2] Hoffman, G., & Ju, W. (2014). Designing robots with movement in mind. *Journal of Human-Robot Interaction*, *3*(1), 91-122.

9/14 Thu	Robot Movement and Gesture	[1] A. Dragan, S. Srinivasa, "Integrating Human Observer Inferences into Robot Motion Planning", Autonomous Robots, 2014. [2] Admoni, H., Weng, T., Hayes, B., & Scassellati, B. (2016, March). Robot nonverbal behavior improves task performance in difficult collaborations. In *2016 11th ACM/IEEE International Conference on Human-Robot Interaction (HRI)* (pp. 51-58). IEEE. * **Project Proposal Due (10%)**
9/19 Tue	Proxemics and Social Navigation	[1] Mead, R., & Matarić, M. J. (2017). Autonomous human–robot proxemics: socially aware navigation based on interaction potential. *Autonomous Robots*, *41*(5), 1189-1201. [2] Yu, X., Hoggenmueller, M., & Tomitsch, M. (2023, March). Your Way Or My Way: Improving Human-Robot Co-Navigation Through Robot Intent and Pedestrian Prediction Visualisations. In *Proceedings of the 2023 ACM/IEEE International Conference on Human-Robot Interaction* (pp. 211-221).
9/21 Thu	Gaze	[1] Gillet, S., Parreira, M. T., Vázquez, M., & Leite, I. (2022, March). Learning gaze behaviors for balancing participation in group human-robot interactions. In *2022 17th ACM/IEEE International Conference on Human-Robot Interaction (HRI)* (pp. 265-274). IEEE. [2] Mutlu, B., Kanda, T., Forlizzi, J., Hodgins, J., & Ishiguro, H. (2012). Conversational gaze mechanisms for humanlike robots. *ACM Transactions on Interactive Intelligent Systems (TiiS)*, *1*(2), 1-33.
9/26 Tue	Embodied Conversation	[1] Thomaz, A., Hoffman, G., & Cakmak, M. (2016). Computational human-robot interaction. Foundations and Trends® in Robotics, 4(2-3), page 122-133. [2] Murray, M., Walker, N., Nanavati, A., Alves-Oliveira, P., Filippov, N., Sauppe, A., ... & Cakmak, M. (2022, January). Learning backchanneling behaviors for a social robot via data augmentation from human-human conversations. In *Conference on Robot Learning* (pp. 513-525). PMLR.
9/28 Thu	Emotion and Affect	[1] Jung, M. F. (2017, March). Affective grounding in human-robot interaction. In *Proceedings of the 2017 ACM/IEEE International Conference on Human-Robot Interaction* (pp. 263-273). [2] Gordon, G., Spaulding, S., Westlund, J. K., Lee, J. J., Plummer, L., Martinez, M., ... & Breazeal, C. (2016, March). Affective personalization of a social robot tutor for children's second language skills. In *Proceedings of the AAAI conference on artificial intelligence* (Vol. 30, No. 1).
10/3 Tue	Theory of Mind	[1] Breazeal, C., Berlin, M., Brooks, A., Gray, J., & Thomaz, A. L. (2006). Using perspective taking to learn from ambiguous demonstrations. *Robotics and autonomous systems*, *54*(5), 385-393. [2] Lee, J. J., Sha, F., & Breazeal, C. (2019, March). A

		Bayesian theory of mind approach to nonverbal communication. In *2019 14th ACM/IEEE International Conference on Human-Robot Interaction (HRI)* (pp. 487-496). IEEE.
10/5 Thu	Robot Learning	[1] Thomaz, A. L., Berlin, M., & Breazeal, C. (2005, August). An embodied computational model of social referencing. In *ROMAN 2005. IEEE International Workshop on Robot and Human Interactive Communication, 2005.* (pp. 591-598). IEEE. [2] Argall, B. D., Chernova, S., Veloso, M., & Browning, B. (2009). A survey of robot learning from demonstration. *Robotics and autonomous systems*, *57*(5), 469-483.
10/10 Tue	No class (October Break)	N/A
10/12 Thu	Robot Learning	[1] McQuillin, E., Churamani, N., & Gunes, H. (2022, March). Learning socially appropriate robo-waiter behaviours through real-time user feedback. In *2022 17th ACM/IEEE International Conference on Human-Robot Interaction (HRI)* (pp. 541-550). IEEE. [2] van Waveren, S., Pek, C., Tumova, J., & Leite, I. (2022, March). Correct me if I'm wrong: Using non-experts to repair reinforcement learning policies. In *2022 17th ACM/IEEE International Conference on Human-Robot Interaction (HRI)* (pp. 493-501). IEEE.
10/17 Tue	Personalization	[1] Shi, Z., Groechel, T., Jain, S., Chima, K., Rudovic, O., & Matarić, M. (2022). Toward Personalized Affect-Aware Socially Assistive Robot Tutors for Long-Term Interventions with Children with Autism. J. Hum.-Robot Interact. 11, 4, Article 39 (December 2022), 28 pages. https://doi.org/10.1145/3526111 [2] Brawer, J., Ghose, D., Candon, K., Qin, M., Roncone, A., Vázquez, M., & Scassellati, B. (2023). Interactive Policy Shaping for Human-Robot Collaboration with Transparent Matrix Overlays.
10/19 Thu	Human-Robot Collaboration	[1] Hoffman, G. (2019). Evaluating fluency in human–robot collaboration. *IEEE Transactions on Human-Machine Systems*, *49*(3), 209-218. [2] Nemlekar, H., Dhanaraj, N., Guan, A., Gupta, S. K., & Nikolaidis, S. (2023, March). Transfer Learning of Human Preferences for Proactive Robot Assistance in Assembly Tasks. In *Proceedings of the 2023 ACM/IEEE International Conference on Human-Robot Interaction* (pp. 575-583). * **Project Checkpoint 1 (10%)**
10/24 Tue	Group Interaction	[1] Booth, S., Tompkin, J., Pfister, H., Waldo, J., Gajos, K., & Nagpal, R. (2017, March). Piggybacking robots: Human-robot overtrust in university dormitory security. In *Proceedings of the 2017 ACM/IEEE International Conference on Human-Robot Interaction* (pp. 426-434). [2] Erel, H., Carsenti, E., & Zuckerman, O. (2022, March). A

		carryover effect in hri: Beyond direct social effects in human-robot interaction. In *2022 17th ACM/IEEE International Conference on Human-Robot Interaction (HRI)* (pp. 342-352). IEEE.
10/26 Thu	Robot Roles	[1] Li, J., Ju, W., & Nass, C. (2015, March). Observer perception of dominance and mirroring behavior in human-robot relationships. In *Proceedings of the Tenth Annual ACM/IEEE International Conference on Human-Robot Interaction* (pp. 133-140). [2] Jeong, S., Aymerich-Franch, L., Alghowinem, S., Picard, R., Breazeal, C, & Park, H. (2023). A Robotic Companion for Psychological Well-being: A Long-term Investigation of Companionship and Therapeutic Alliance. Proceedings of the 2023 ACM/IEEE International Conference on Human-Robot Interaction (HRI).
10/31 Tue	Error and Repair	[1] Salem, M., Lakatos, G., Amirabdollahian, F., & Dautenhahn, K. (2015, March). Would you trust a (faulty) robot? Effects of error, task type and personality on human-robot cooperation and trust. In *Proceedings of the tenth annual ACM/IEEE international conference on human-robot interaction* (pp. 141-148). [2] Stiber, M., Taylor, R. H., & Huang, C. M. (2023). On Using Social Signals to Enable Flexible Error-Aware HRI.
11/2 Thu	HRI in Education	[1] Belpaeme, T., Kennedy, J., Ramachandran, A., Scassellati, B., & Tanaka, F. (2018). Social robots for education: A review. *Science robotics*, *3*(21), eaat5954. [2] Ligthart, M. E., de Droog, S. M., Bossema, M., Elloumi, L., Hoogland, K., Smakman, M. H., ... & Ben Allouch, S. (2023, March). Design Specifications for a Social Robot Math Tutor. In *Proceedings of the 2023 ACM/IEEE International Conference on Human-Robot Interaction* (pp. 321-330).
11/7 Tue	HRI in Healthcare	[1] Scassellati, B., Boccanfuso, L., Huang, C. M., Mademtzi, M., Qin, M., Salomons, N., ... & Shic, F. (2018). Improving social skills in children with ASD using a long-term, in-home social robot. *Science Robotics*, *3*(21), eaat7544. [2] Stegner, L., & Mutlu, B. (2022, June). Designing for Caregiving: Integrating Robotic Assistance in Senior Living Communities. In *Designing Interactive Systems Conference* (pp. 1934-1947).
11/9 Thu	HRI in Public Space	[1] Kamino, W., & Sabanovic, S. (2023, March). Coffee, Tea, Robots? The Performative Staging of Service Robots in'Robot Cafes' in Japan. In *Proceedings of the 2023 ACM/IEEE International Conference on Human-Robot Interaction* (pp. 183-191). [2] Brščić, D., Kidokoro, H., Suehiro, Y., & Kanda, T. (2015, March). Escaping from children's abuse of social robots. In *Proceedings of the tenth annual acm/ieee international conference on human-robot interaction* (pp. 59-66). * **Project Checkpoint 2 (10%)**

11/14 Tue	HRI and Accessibility	[1] Neto, I., Correia, F., Rocha, F., Piedade, P., Paiva, A., & Nicolau, H. (2023, March). The Robot Made Us Hear Each Other: Fostering Inclusive Conversations among Mixed-Visual Ability Children. In *Proceedings of the 2023 ACM/IEEE International Conference on Human-Robot Interaction* (pp. 13-23). [2] Nanavati, A., Alves-Oliveira, P., Schrenk, T., Gordon, E. K., Cakmak, M., & Srinivasa, S. S. (2023, March). Design Principles for Robot-Assisted Feeding in Social Contexts. In *Proceedings of the 2023 ACM/IEEE International Conference on Human-Robot Interaction* (pp. 24-33).
11/16 Thu	End-user Programming	[1] Gao, Y., & Huang, C. M. (2019, March). PATI: a projection-based augmented table-top interface for robot programming. In *Proceedings of the 24th international conference on intelligent user interfaces* (pp. 345-355). [2] Porfirio, D., Stegner, L., Cakmak, M., Sauppé, A., Albarghouthi, A., & Mutlu, B. (2023). Sketching Robot Programs On the Fly. *arXiv preprint arXiv:2302.03088*.
11/21 Tue	Long-term In-the-wild HRI	[1] Nanavati, A., Walker, N., Taber, L., Mavrogiannis, C., Takayama, L., Cakmak, M., & Srinivasa, S. (2022, March). Not All Who Wander Are Lost: A Localization-Free System for In-the-Wild Mobile Robot Deployments. In *2022 17th ACM/IEEE International Conference on Human-Robot Interaction (HRI)* (pp. 422-431). IEEE. [2] Rueben, M., Syed, M., London, E., Camarena, M., Shin, E., Zhang, Y., ... & Matarić, M. J. (2021, October). Long-term, in-the-wild study of feedback about speech intelligibility for k-12 students attending class via a telepresence robot. In *Proceedings of the 2021 International Conference on Multimodal Interaction* (pp. 567-576).
11/23 Thu	No class (Thanksgiving Break)	N/A
11/28 Tue	No class (Thanksgiving Break)	N/A
11/30 Thu	HRI and legal policy	Guest speaker: Daniella Dipaola, MIT [1] Darling, K. (2016). Extending legal protection to social robots: The effects of anthropomorphism, empathy, and violent behavior towards robotic objects. In *Robot law* (pp. 213-232). Edward Elgar Publishing.
12/5 Tue	Final Project Presentation	N/A
12/7 Thu	Final Project Presentation	* **Project Report Due (20%)**

Grading

- 30% Analytical reading responses
- 10% Discussion leadership
- 10% Project proposal
- 10% Project checkpoint 1
- 10% Project checkpoint 2
- 20% Final project presentation and write-up
- 10% Attendance and discussion participation