

CS 7000 / ATLS 5519: Human-Robot Interaction

Spring 2017

Monday/Wednesday 1:00pm – 2:15pm | ATLS 229

Professor:

Dan Szafir daniel.szafir@colorado.edu

Office Hours:

TBD, for now by appointment. Office: ATLS 217

Description:

The field of human-robot interaction (HRI) is rapidly emerging as a significant interdisciplinary research area that focuses on developing robotic technologies and interfaces that enable robots to effectively work with and alongside people. This course will introduce students to HRI theory, principles, methodologies, and applications by bringing together knowledge from robotics, artificial intelligence, human factors, human-computer interaction, design, cognitive psychology, education and other domains. Coursework will include readings and discussions focused on the state-of-the-art in HRI research, focused team exercises and problem-solving sessions involving human-robot interaction challenges, and a team project resulting in the implementation and evaluation of a human-robot interaction system for specific applications.

Course Objectives:

This course introduces students to the field of Human-Robot Interaction. Topics will include:

- The historical development of HRI
- HRI Tools and Methods
- Experimental design relating to HRI
- Robotic algorithms and sensors
- Social robotics
- Interface design

By the end of the course, students will have gained knowledge and skills to:

- Understand the fundamental concepts relating to HRI such as design, implementation, and evaluation
- Read deeply, understand, and critique academic research papers relating to HRI
- Create algorithms guiding robot behaviors and design robot interfaces with the context of HRI
- Apply findings from relevant psychology and social sciences to the design of interactive robots
- Work successfully with a group of peers from a variety of disciplines on a research project
- Conduct human-subjects research within the scope of HRI
- Communicate and present individual and group project work

Textbook:

This course will not have a textbook. All readings will be posted online.

Course Pre-Requisites:

This is a graduate course intended for those considering serious research in human-robot interaction. The course project may involve significant programming and development, thus students will be expected to have a solid mastery of computer science concepts and programming languages as a prerequisite for this course. All students will be learning new skill sets and are expected to be strongly motivated to work with novel robotic platforms.

Course Format:

The course will be comprised of lectures, readings, discussions, exercises, assignments, presentations, and projects. All readings will be posted online and discussion will occur the following class. Several readings will be presented by students to encourage fundamental knowledge acquisition. We will occasionally have a short (10 min) quiz before each lecture/set of presentations to test the understanding of the readings. Certain topics may additionally include a minor programming assignment or problem set. Students will either carry out a final research project in teams or conduct an in-depth literature survey individually.

Grading:

10% - Consistent attendance and active participation

25% - Quizzes, reading responses, programming exercises, and problem sets

30% - Student presentations and methods assignments:

Each student will get the opportunity to present multiple times in this course. Some presentations may be based on course readings. You will be graded based on your level of insight into the material (including how well you answer questions from the rest of the class), how well you relate the paper to other papers and lecture material, as well as how well you present the material to the class. Other presentations will involve the final project, including a poster presentation at the end of the course.

Students will additionally have several short assignments involving the use of the human-subjects research methods taught in this course. Each of these assignments will involve a 1-page write-up describing the process and results.

35% - Final project:

Students will have a choice between a research project (as part of a team) or an in-depth literature survey (individually; ~50 relevant papers, organized by different features, identifying gaps in the state of the art). Students will submit a proposal along the way (1 page + presentation) and a final presentation and report (up to 8 pages) at the end of the course.

Absences without prior notification will downgrade a student's final grade as follows:

3 absences: -5 points

4 absences: -10 points

5 absences: automatic failure

Important Dates:

- Monday 2/6 – Preliminary project proposals (individual in class presentations)
You will present a preliminary proposal for an HRI research project. Come talk to me about your project early on, especially if you'd like us to write a paper on it.
- Monday 2/13 – Preliminary project presentations (group in class presentations)
Your team will present a more concrete version of your group project
- Wednesday 3/8 – Interim project proposals (1 page) due.
By now you should have a clear idea of what you want to do and what your key insight is in the case of a project or how you will select and classify papers in the case of a literature survey.
- Monday 5/1 & Wednesday 5/3 – Final Presentations (in class)
- Monday 5/8 – Final Report Due

Tentative Schedule (this will change – it is your responsibility to keep track of schedule changes and updates, which will be posted on Moodle):

#	Day	Date	Lecture & Reading Topic	Potential Readings Due (see Moodle for posts)	Notes
1	Wed	1/18	Course Introduction	None	
2	Mon	1/23	Project Speed-Dating	None	
3	Wed	1/25	Introduction to HRI Research Methods	<ul style="list-style-type: none"> Goodrich: Human-robot interaction: a survey (2007) 	
4	Mon	1/30	Project pitches	None	Students pitch project ideas. Teams formed, teams choose topics. Project goals and timeline are discussed. Teams work and seek feedback from the instructor.
5	Wed	2/1	Methodology Matters	<ul style="list-style-type: none"> McGrath, J. E. (1995). Methodology Matters: Doing Research in the behavioral and social sciences. In R. M. Baecker, J. Grudin, W. A. S. Buxton, S. Greenberg, (eds.), Readings in Human-Computer Interaction: Toward the Year 2000, pp. 152–169. Simmons et al. “Believable robot 	

				characters ” AI Magazine 2011	
6	Mon	2/6	Project work session	None	Teams work and seek feedback from the instructor.
7	Wed	2/8	Methodological Fit	<ul style="list-style-type: none"> • Lazar, J., Feng, J. H., & Hochheiser, H. (2010). Chapter 14: “Working with Human Subjects” in Research Methods in Human-Computer Interaction. Wiley. • Fischer, G. (2001). User modeling in human-computer interaction, User Modeling and User-Adapted Interaction, 11 (1), 65–86. • Edmondson, A. C., & McManus, S. E. (2007). Methodological Fit in Management Field Research. The Academy of Management Review, 32 (4), 1155–1179. 	
8	Mon	2/13	Preliminary Project Presentations	None	Project teams will present their findings from a survey of previous work in the problem area. The goal of this stage is to identify significant but unexplored phenomena

					in the problem area that teams will focus on for their exploration.
9	Wed	2/15	Fundamentals of Experimental Design	<ul style="list-style-type: none"> • D. Fallman. “Design-oriented human-computer interaction.” CHI 2003 • Nass, C. & Moon, Y. (2000). Machines and mindlessness: Social responses to computers. Journal of Social Issues, 56 (1): 81-103. • Cassell, J. (2001). Embodied conversational agents: Representation and intelligence in user interfaces. AI Magazine, 22 (4): 67-83. 	
10	Mon	2/20	Step-by-Step Experimental Design	TBA	
11	Wed	2/22	Catchup / Project Work	<ul style="list-style-type: none"> • Gergle, D., & Tan, D. (2014). Experimental Research in HCI. In Ways of Knowing in HCI. • T. Fong et al., “A survey of socially interactive robots”, RAS 2003. • Mutlu, B. & Forlizzi, J. (2008). Robots in organizations: the role of workflow, social, and environmental factors in human-robot interaction. HRI 2008 • Mutlu, B., Shiwa, T., Kanda, T., Ishiguro, H., and Hagita, N. 	

				<p>(2009). Footling in human-robot conversations: how robots might shape participant roles using gaze cues. HRI 2009</p> <ul style="list-style-type: none"> • C. Breazeal & A. Thomaz. Learning from human teachers with socially guided exploration. ICRA 2008 	
12	Mon	2/27	Measuring in HRI Research I	None	
13	Wed	3/1	Measuring in HRI Research II	<ul style="list-style-type: none"> • J. Lasseter, "Principles of Traditional Animation applied to 3D Computer Animation", in Computer Graphics, 1987. • D. Baldwin and J. Baird, "Discerning Intentions in Dynamic Human Action" TICS 2001 • "Planning Based Prediction for Pedestrians" (2009)pdf • A. Steinfeld et al., "Common metrics for human-robot interaction" (2006) 	
14	Mon	3/6	Measuring in HRI Research III	<ul style="list-style-type: none"> • "Generating Legible Motion (2013)" pdf • "Understanding and Sharing Intentions" (2005) pdf • "Obsessed with Goals" (2007) pdf 	Teams work and seek feedback from the instructor.
15	Wed	3/8	Interim Project Presentations	None	1-page project interim report due
16	Mon	3/13	Measuring in HRI Research IV	<ul style="list-style-type: none"> • "Robot Navigation in Dense Human Crowds" (2012) pdf 	

				<ul style="list-style-type: none"> • "Improving Robot Readability" (2011) pdf • "Communication of Intent in Assistive Free Flyers" (2014) pdf 	
17	Wed	3/15	Scale Construction		
18	Mon	3/20	Introduction to Descriptive and Inferential Statistics		
19	Wed	3/22	Analysis of Variance	<ul style="list-style-type: none"> • "Knowledge and Implicature" (2013) pdf • "Rhetorical Robots" (2013) link • "Simon Plays Simon Says" (2011) pdf 	
20	Mon	3/27	NO CLASS	Spring Break	
21	Wed	3/29	NO CLASS	Spring Break	
22	Mon	4/3	Further Inferential Statistics	<ul style="list-style-type: none"> • B. Mutlu et al., "Nonverbal leakage in Robots" HRI 2009. • Szafir, D. and Mutlu, B. Pay attention! Designing Adaptive Agents that Monitor and Improve User Engagement. In CHI 2012 	
23	Wed	4/5	Field Research, Ethnographic Methods, and Grounded Theory	<ul style="list-style-type: none"> • "Shared Cooperative Activity" (1992) pdf • "Mixed Initiative Systems" (2007) pdf • "A Minimal Architecture for Joint Action" (2010)pdf • Fong et al. Collaboration, dialogue, human-robot interaction. Robotics Research 2003 	
24	Mon	4/10	Topics: HRI and Flying Robots	<ul style="list-style-type: none"> • Szafir et al. "Communicating Directionality in Flying Robots" HRI 2015 • Cauchard et al. "Drone & me: an exploration 	

				into natural human-drone interaction” UbiComp 2015	
25	Wed	4/12	Topics: Bayesian Methods in HRI	<ul style="list-style-type: none"> Fong et al. “Robot, asker of questions.” RAS 2003 Johnson et al. “Coactive design: Designing support for interdependence in joint activity” JHRI 2014 	
26	Mon	4/17	Topics: Learning by Demonstration	<ul style="list-style-type: none"> B. Argall et al., “A Survey of Robot Learning by Demonstration” Robotics and Autonomous Systems 2009. A. Billard et al. “Robot Programming by Demonstration” <i>Handbook of Robotics, Ch 59, 2007.</i> S. Calinon and A. Billard, “Active Teaching in Robot Programming by Demonstration” RO-MAN 2007. R. Castro et al., “Human Active Learning” NIPS 2008. M. Cakmak et al., “Designing Interactions for Robot Active Learners” IEEE Trans. on Autonomous Mental Development, 2010. 	
27	Wed	4/19	Topics: Robotic Telepresence	<ul style="list-style-type: none"> Rae et al. “In-body experiences: embodiment, control, and trust in robot-mediated communication.” CHI 2013 	

				<ul style="list-style-type: none"> Tsui et al. "Exploring use cases for telepresence robots" HRI 2011 	
28	Mon	4/24	Project work session	None	Teams work and seek feedback from the instructor.
29	Wed	4/26	Topics: Social Robotics	<ul style="list-style-type: none"> C. Breazeal, "Emotion and Sociable Humanoid Robots," Int. J. Human-Computer Studies, 2003. D. Norman "Emotional Design", Ch. 6 & 7, 2004. S. Klemmer et al., "How bodies matter", DIS 2006. 	
30	Mon	5/1	Project work session	None	Teams work and seek feedback from the instructor.
31	Wed	5/3	Project Presentations	None	Project teams will present their overall project process and discuss the implications of their findings
32	Mon	5/8	Final Report Due		

Accommodation for Disabilities

If you qualify for accommodations because of a disability, please submit to your professor a letter from Disability Services in a timely manner (for exam accommodations provide your letter at least one week prior to the exam) so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities. Contact Disability Services at [303-492-8671](tel:303-492-8671) or by e-mail at dsinfo@colorado.edu. If you have a temporary medical condition or injury, see [Temporary Injuries guidelines](#) under the Quick Links at the [Disability Services website](#) and discuss your needs with your professor.

Religious Holidays

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, please notify the instructor **at least two weeks prior** to any conflict due to a religious obligation to ensure proper accommodations can be made. The instructor may not be able to support conflicts when given less than two weeks advance notice.

See [campus policy regarding religious observances](#) for full details

Classroom Behavior

Students and faculty each have responsibility for maintaining an appropriate learning environment. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, color, culture, religion, creed, politics, veteran's status, sexual orientation, gender, gender identity and gender expression, age, disability, and nationalities. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. For more information, see the [policies on classroom behavior](#) and [the student code](#).

Discrimination and Harassment

The University of Colorado Boulder (CU-Boulder) is committed to maintaining a positive learning, working, and living environment. CU-Boulder will not tolerate acts of discrimination or harassment based upon Protected Classes or related retaliation against or by any employee or student. For purposes of this CU-Boulder policy, "Protected Classes" refers to race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. Individuals who believe they have been discriminated against should contact the Office of Institutional Equity and Compliance (OIEC) at [303-492-2127](tel:303-492-2127) or the Office of Student Conduct and Conflict Resolution (OSC) at [303-492-5550](tel:303-492-5550). Information about the OIEC, the above referenced policies, and the campus resources available to assist individuals regarding discrimination or harassment can be found at the [OIEC website](#). The [full policy on discrimination and harassment](#) contains additional information.

Honor Code

All students of the University of Colorado at Boulder are responsible for knowing and adhering to [the academic integrity policy](#) of this institution. Violations of this policy may include: cheating, plagiarism, aid of academic dishonesty, fabrication, lying, bribery, and threatening behavior. All incidents of academic misconduct shall be reported to the Honor Code Council (honor@colorado.edu; [303-735-2273](tel:303-735-2273)). Students who are found to be in violation of the academic integrity policy will be subject to both academic sanctions from the faculty member and non-academic sanctions (including but not limited to university probation, suspension, or expulsion). Additional information regarding the [Honor Code policy can be found online](#) and at the [Honor Code Office](#).

Copyrighted Material

Unless students are intentionally exploring the idea of remix and/or appropriation and have previously discussed this with the professor, they should avoid using copyrighted material in creative work for this course. Students are encouraged to create their own media assets (imagery, sound, etc.).

“Double Dipping”

“Double Dipping,” or submitting work (paper, project, etc.) for this course that has already been submitted to other classes, is prohibited and is a violation of the CU Honor Code <http://honorcode.colorado.edu>.

Resources

Writing Center: <http://www.colorado.edu/pwr/writingcenter.html>

Student resources and support services: <http://www.colorado.edu/international/resources-support-services>

Syllabus Adjustment

The professor reserves the right to modify this syllabus at any time and will notify students in a timely manner should any modifications occur. Questions regarding the syllabus should be directed to the professor.