16-467: Human-Robot Interaction

Spring 2018

Class Sessions:
T & Th 12–1:20pm
NSH 3002

Website:
`https://canvas.cmu.edu/courses/3003`
See website for most up-to-date information.

Professor:
Henny Admoni (`henny@cmu.edu`)

Teaching Assistant:
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Professor Office Hours:
T 1:30–2:30pm, W 4–5pm
NSH 4529

TA Office Hours:
M & Th 10–11am
NSH 4502 (HARP Lab)

Course Description

The field of human-robot interaction (HRI) is fast becoming a significant area of research in robotics. The basic objective is to create natural and effective interactions between people and robots. HRI is highly interdisciplinary, bringing together methodologies and techniques from robotics, artificial intelligence, human-computer interaction, psychology, education, and other fields. This course is primarily lecture-based, with in-class exercises, mini-projects, a group term project that will enable students to put theory to practice, and a final. The topics covered will include technologies that enable human-robot interactions, the psychology of interaction between people and robots, how to design and conduct HRI studies, and real-world applications such as assistive robots. This course has no prerequisites, but some basic familiarity with robots is recommended (programming knowledge is not necessary, but is useful for the term project).

Should I take this course? This class is designed for advanced undergraduates who are interested in a survey of human-robot interaction. While we will cover some specific algorithms and techniques in depth, the main goal of the class is to give students a broad understanding of this diverse and interdisciplinary field, which includes learning about the computer science, engineering, psychology, and design aspects of HRI. The term project will give students a chance to delve more deeply into a specific area of interest within HRI. To benefit fully, in-class participation is highly encouraged.

Learning Objectives

There are two main goals for this course. The first goal is to give you a broad introduction to the interdisciplinary topics that comprise the field of human-robot interaction. The second goal is to give you basic skills for evaluating and conducting human-robot interaction research.

By the end of the course, you should be able to:

1. understand how principles of psychology and design influence human-robot interactions (e.g., verbal and nonverbal communication, theory of mind, anthropomorphism, etc.)
2. recognize computational structures that enable HRI (e.g., cognitive architectures, probabilistic models of behavior, frameworks for generating intentional motion, etc.)

3. describe real-world applications of HRI and the current state of the art in those areas
4. design an HRI study involving human subjects
5. analyze and interpret data from a human subjects study
6. conduct an in-depth investigation of an HRI concept of interest

Grades

Component	Percentage
In-class exercises	25%
Mini-projects	25%
Term project	20%
Final exam	20%
Quizzes	10%

In-class exercises. Throughout the semester, you will complete in-class exercises to build an in-depth understanding of certain ideas and techniques presented during the lectures. These hands-on exercises may be performed individually or in small groups during class time, but will be submitted and graded individually. Doing these exercises in class will give you a chance to get feedback from the professor and TA as you work through the material.

Mini-projects. Within the first four weeks of the semester, students will establish project teams of 3-5 people. These teams will be the same for all of the mini-projects and the term project during the semester.

Mini-projects will be completed collaboratively by the project team (outside of class time), with one completed response submitted per team. These assignments will guide you through the process of designing, executing, and reporting on an HRI project. Thus, completing the mini-projects well will not only help your grade, it will help you conduct a successful term project. You can expect about seven mini-projects over the course of the semester, which will range from written reports to check-in presentations. Details and deadlines for these mini-projects will be distributed in class.

Term project. The term project will be a substantial piece of work performed with your project team that will allow you to delve more deeply into an area of interest within HRI. The term project will include a final written report and an in-class presentation.

Because HRI is inherently interdisciplinary, one requirement of this project is that it must involve two components of HRI from the following list.

- algorithmic or software development
- fabrication or engineering
- design
- user study

These categories are intentionally broad to give you flexibility to create a project that you find most interesting. For example, you might conduct a user-centered design process to identify requirements

for a home robot assistant, then develop robot behavior software in simulation that satisfies the design requirements you identified. As another example, you might 3D print a new gripper for a teleoperated assistive robot arm, then conduct a user study to evaluate whether your newly fabricated gripper is easier for people to use than existing grippers.

The term project must be approved by the TA or professor, or it will have to be revised to meet expectations. The term project will build from the mini-projects that are assigned earlier in the semester, but you should be working toward the term project consistently throughout the semester. Since the project will require at least two distinct HRI components, you are encouraged to build a project team that has complementary skills.

Projects will be evaluated on:

- Demonstrated understanding of course content and integration of two HRI components (60%)
- Quality of final report (20%)
- Quality of final presentation (20%)

Final exam. A final exam will evaluate your content knowledge from the class. This exam will be scheduled during the standard CMU exam period.

Quizzes. Most Thursdays, there will be a short (10 minute) quiz on the material from the previous lecture and the readings (if any) for the day. This quiz is intended to ensure that you are keeping pace with the material and are prepared for the day's lecture. It is not meant to be onerous. Your lowest quiz grade is dropped when calculating your final grade in the course. There will be no makeup quizzes.

Participation. You will get the most out of this class if you are active and engaged. This includes asking questions and participating during lectures and discussions. Though participation is not explicitly graded, you are expected to be an active part of this class.

Policies

Academic Integrity

Plagiarism and cheating will not be tolerated in this course. I follow CMU's academic integrity policy: `http://www.cmu.edu/policies/student-and-student-life/academic-integrity.html`

All content produced for this class must be original to the submitter(s). Plagiarism is a very serious offense and will be treated as such. Any sources of information should be cited correctly. Any material taken directly from the source, including figures, must be clearly quoted and attributed.

Collaboration is integral to learning, but it is important to acknowledge such collaborations. Thus, you are encouraged to discuss course material outside of class, but any assistance you get on graded material (i.e., in-class exercises, mini-projects, and the term project) should be acknowledged. This includes assistance from project team members, other classmates, and CMU academic resources. You can acknowledge assistance by including an acknowledgments slide (for presentations) or section (for written assignments) detailing who helped and in what way.

If you have *any* question about whether something is allowable, please email me.

Diversity and Inclusive Learning

I recognize that students come from different backgrounds and learn in different ways, and I strive to create a class environment where all students feel supported and encouraged to ask questions and engage in discussion. I intend to create a class that is respectful of diversity including gender identity, sexuality, disability, age, socioeconomic status, religion, ethnicity, race, national origin, and culture.

Some of my research involves creating robots for people with disabilities, and I feel strongly that diversity in the classroom includes accommodating diverse abilities. If you wish to request accommodation for a documented disability, please first contact Disability Resources (412-268-2013 or `access@andrew.cmu.edu`), then let me know as soon as possible so we can discuss reasonable accommodations. If you suspect that you may have a disability and would benefit from accommodations but are not yet registered with the Office of Disability Resources, I encourage you to contact them at `access@andrew.cmu.edu`.

Extensions and Late Assignments

Being late means failing to provide a deliverable (e.g., a written report, a presentation, or a completed quiz) in the requested format (e.g., email, Canvas upload, or in class) by the stated deadline. For in-class exercises, mini-projects, and term projects, the deadline for submitting materials will be identified in the instructions. For presentations, quizzes, and the final exam, failing to complete the task *in the class period for which it was scheduled* will be counted as late.

Late assignments will be docked 10% of their grade for each 24 hour period, up to 3 days, that they are late. So, for example, if a mini-project is submitted 12 hours past the submission deadline, and it scores 87%, its grade will be recorded as 77%. The only exception to this is in the case of emergency. If you experience an emergency and need to reschedule a presentation or extend an assignment deadline, you must contact me as early as possible to discuss this request.

There will be no make-up for late quizzes, though the lowest quiz grade will be dropped at the end of the term. There will be no make-up final exam.

Expectations

These guidelines are intended to create a comfortable and productive learning environment.

You can expect me to:

- start and end class on time.
- reply to emails within 36 hours on weekdays and 48 hours on weekends.
- grade your quizzes and send you feedback on your assignments in a timely manner.
- be available for office hours at specified times.

I expect you to:

- come to class on time.
- be attentive and engaged in class.

- refrain from using laptops, cell phones, or other electronic devices during class, except as specifically needed for your learning.
- take notes and ask questions when something is unclear.
- do the assigned readings before the class period in which they are discussed.
- work diligently on your assignments and term project.

Statement of Support for Students' Health and Well-being

Take care of yourself. Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress.

All of us benefit from support during times of struggle. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is almost always helpful.

If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, I strongly encourage you to seek support. Counseling and Psychological Services (CaPS) is here to help: call 412-268-2922 and visit their website at `http://www.cmu.edu/counseling/`. Consider reaching out to a friend, faculty or family member you trust to get connected to the support that can help.

Fundamentals

- autonomy
- appearance and anthropomorphism
- nonverbal and verbal communication
- emotion

Applications

- intention
- social navigation
- learning from demonstration
- collaboration

Tools

- computational frameworks
- study design
- data analysis

Real-world impact

- socially assistive robotics
- physically assertive robotics
- robots in education
- ethics