ECE 750 Topic 35, ECE 493 Topic 26

Wednesday/Thursday, 10-11:20am, E7-5353

Abbreviated title: **Social Robotics**

Full course title:
Social Robotics - Foundations, Technology and Applications of Human-Centered Robotics

(Winter 2025) Fully In-Person (will move online if necessary due to Covid-19)

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Office hour (to be confirmed during first week of classes): Thursday 11:45am-12:45pm, E5-5027

Text: Textbook chapters (as PDF available online): Bartneck, C., Belpaeme, T., Eyssel, F., Kanda, T., Keijsers, M., & Sabanovic, S. (2020). Human-Robot Interaction – An Introduction. Cambridge: Cambridge University additional. Additional readings will be made available to students.

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The course will provide an introduction to the research field of social robotics, with a particular human-centered perspective. Human-robot interaction is a highly interdisciplinary area of research that takes inspiration and adopts methods from a range of disciplines, including social sciences, ethology, primatology, developmental psychology, computer science, engineering and Artificial Intelligence. Robots that can interact socially in an effective and acceptable manner with people have become increasingly important for applications ranging from robot-assisted therapy for people with special needs, robotic assistants for older people and care home residents, robots as tools in education or robotic co-workers for a new generation of industrial robot that emphasize human-machine collaboration and communication. Ideas, theories, approaches and applications will be discussed and critically reflected upon. Students will gain an understanding of the concepts and theories underlying social robotics, as well as research methodologies and techniques to realize socially intelligent robots and design, plan and evaluate human-robot interaction experiments.

Course Outline:
Target topics include*:

1. Definitions of social robots and requirements of robots' social skill and their relevance to robotics and Artificial Intelligence in real-world applications
2. Examples of social robots used in human-robot interaction (sensors, actuators, how to program etc.)
3. Multimodal interaction with social robots, including verbal interaction (e.g. speech and dialogue), non-verbal interaction (e.g. gestures, facial expression) as well as spatial interaction (proxemics)
4. The role of affective expressions of social robots and modelling emotions to facilitate human-robot engagement
5. Research methods and measures for planning, designing, implementing, running, evaluating, analyzing experiments. Areas discussed include e.g. questionnaire design, interviews and behavioral measures. Different experimental designs, protocols and methods for participant recruitment will be discussed.
6. Evaluating usability, user experience and acceptance of social robots
7. Guidelines of how to write up social robotics research for a scientific publication

8. Overview of cognitive architectures for socially intelligent robots
9. Featuring interdisciplinary research in social robotics based on research from other fields, e.g. from (developmental) psychology, ethology or primatology
10. Impact of social robot embodiments, behavior and interaction
11. Roles of social robots in human society and their potential impact on society and wellbeing
12. Selected examples of applications of social robots e.g. in care, therapy, education, rehabilitation and co-worker scenarios will be discussed throughout the course
13. Ethical, safety and privacy issues as relevant to social robotics will be discussed throughout the course

*The instructor remains the right to modify the content and order of topics covered in the lectures which may be adjusted e.g. due to recent developments in the field.

Course Grading for Graduate Students:

- 20% Assignments. Two assignments will assess students' understanding of concepts, definitions, methods, methodologies, procedures and challenges in social robotics research, testing an understanding of material covered in the lectures. One assignment will be scheduled around mid-term, the other one towards the end of term.
- 20% Individual discussion paper: Students will reflect on work in Science Fiction involving the concepts of social and intelligent robots, and reflect on the relevance to today's robotics technology in robotics and Artificial Intelligence. Students can choose the work and discuss the selection with the instructor. A report (IEEE Format, 4 pages maximum) has to be submitted.
- 50% Individual term project: Students will implement a set of non-verbal social behaviours using the open-source 3D robot simulator Webots. Students might also prefer using similar robot simulators with similar functionalities. If students have access, as part of their MASc or PhD studies, to a social robot, they may use it for their project. The simulator already has different humanoid and non-humanoid models available that students can choose from. Students will program expressive robot behaviours based on the current literature on non-verbal human-robot interaction. Students are required to write a report that motivates, describes and discusses those behaviours in light of the state of the art literature, and *describe an experimental design for a human-robot interaction experiment* where those behaviours could be tested and analyzed. A small-scale "pretend" user study with fellow students will provide preliminary data that will be analysed. The report should follow the structure of a research article. Specifically, students' reports will be evaluated based on a) the literature review demonstrating the level of knowledge in this domain, b) the relevance of the identified research questions and hypotheses, c) the depth of the proposed research program, d) the range, complexity and quality of the implemented and documented robot behaviours, e) the detailed description of the methodology used to carry out and analyze this program of work, f) the user study conducted and how results are presented and analysed, and finally, g) a critical evaluation of possible limitations of the expected outcomes and backup plans in order to address possible delays and technical difficulties encountered during the implementation of the work. An 8-page IEEE-style formatted report, including references has to be submitted. The report will prepare students for research in social robotics or HRI. Note, those skills can also be applied to related fields of Human-Computer Interaction (HCI), Human Factors etc.
- 10% Students are required to give a presentation of their individual term project.

Course Grading for Undergraduate Students:

- 20% Assignments. Two assignments will assess students' understanding of concepts,

definitions, methods, methodologies, procedures and challenges in social robotics research, testing an understanding of material covered in the lectures. One assignment will be scheduled around mid-term, the other one towards the end of term.

- 20% Individual discussion paper: Students will reflect on work in Science Fiction involving the concepts of social and intelligent robots, and reflect on the relevance to today's robotics technology in robotics and Artificial Intelligence. Students can choose the work and discuss the selection with the instructor. A report (IEEE Format, 4 pages maximum) will be submitted.
- 50% Individual term project. Students are asked to write a report which consists of a proposal for an envisaged Human-robot interaction (HRI) study. Students will implement a set of non-verbal social behaviours using the open-source 3D robot simulator Webots. The simulator already has different humanoid and non-humanoid models available that students can choose from. Students will program expressive robot behaviours based on the current literature on non-verbal human-robot interaction. Students are required to write a report that motivates, describes and discusses those behaviours in light of the state of the art literature, and *describe a possible experimental design for a human-robot interaction experiment* where those implemented behaviours could be tested and analyzed. A small-scale "pretend" user study with fellow students will provide preliminary data that will be analysed. Students need to identify a topic and research questions, based on what has been covered in the course, written as a research article. Specifically, students' reports will be evaluated based on a) the literature review demonstrating the level of knowledge in this domain, b) the relevance of the identified research questions and hypotheses, c) the depth of the proposed research program, d) the range, complexity and quality of the implemented and documented robot behaviours, e) the detailed description of the methodology used to carry out and analyze this program of work, f) a critical evaluation of possible limitations of the expected outcomes and backup plans in order to address possible delays and technical difficulties encountered during the implementation of the work. An 6-page IEEE-style formatted report, including references has to be submitted. The report will prepare students for research in social robotics or HRI. Note, those skills can also be applied to related fields of Human-Computer Interaction (HCI), Human Factors etc.
- 10% Students are required to submit a 5min video presentation of their individual term project.

Important Dates (all due 23:59pm) **(tentative to be confirmed during first week of classes):**

Wednesday	29 January/19 March 2025	Assignment 1/ Assignment 2 due
Sunday	9 February 2025	Individual Discussion paper due
Sunday	23 February 2025	Individual project proposals due
Tuesday	1 April 2025	Individual project report due
Wed/Thurs	2,3 April 2025	Student presentations in-class (G), video upload (UG)

No classes during Reading week 15-23 February 2025.

Students are expected to attend all lectures, take detailed notes and participate in class discussions. It is expected that students understand the university position on copying (in terms of assignments) and plagiarism (in terms of the discussion paper and project). All material (text, figures, tables etc.) that are not your own must be explicitly identified.

Academic integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility.

[Check the Office of Academic Integrity for more information.]

Generative AI tools: This course includes the independent development and practice of specific skills, such as designing, analysing and writing up a research work. Therefore, the use of Generative artificial intelligence (GenAI) trained using large language models (LLM) or other methods to produce text, images, music, or code, like Chat GPT, DALL-E, or GitHub CoPilot, is not permitted in this class. Unauthorized use in this course, such as running course materials through GenAI or using GenAI to complete a course assessment is considered a violation of Policy 71 (plagiarism or unauthorized aids or assistance). Work produced with the assistance of AI tools does not represent the author's original work and is therefore in violation of the fundamental values of academic integrity including honesty, trust, respect, fairness, responsibility and courage (ICAI, n.d.).

You should be prepared to show your work. To demonstrate your learning, you should keep your rough notes, including research notes, brainstorming, and drafting notes. You may be asked to submit these notes along with earlier drafts of their work, either through saved drafts or saved versions of a document. If the use of GenAI is suspected where not permitted, you may be asked to meet with your instructor or TA to provide explanations to support the submitted material as being your original work. Through this process, if you have not sufficiently supported your work, academic misconduct allegations may be brought to the Associate Dean.

In addition, you should be aware that the legal/copyright status of generative AI inputs and outputs is unclear. More information is available from the Copyright Advisory Committee: https://uwaterloo.ca/copyright-at-waterloo/teaching/generative-artificial-intelligence

Students are encouraged to reach out to campus supports if they need help with their coursework:
Student Success Office for help with skills like notetaking and time management
Writing and Communication Centre for assignments with writing or presentations
AccessAbility Services for documented accommodations
Library for research-based assignments

Rules for Collaboration: Students are strongly encouraged to talk about assigned work, share ideas, or share code fragments. However, each final submission is to be composed individually. Direct copying of a solution, or providing the copy, is considered cheating. Two key things to remember are "separation" and "disclosure."

Separation means that, after you discuss an assignment with other people, you separate yourself from them and from any shared materials while you then individually compose your solution to hand in. In addition to avoiding direct copying, this will significantly improve your speed of learning.

Disclosure means you indicate on the submitted work any significant help you received, and specify any component which you took directly from another source. You may lose whatever portion of the grade relates to the copied part. However, you won't be cheating and you will be learning from the parts you were able to complete on your own.

Email Policy: Only emails from a valid uwaterloo email address will be responded to. The email must contain the full student name and student ID, and include your course number in the subject line. We endeavour to respond within 24 to 48 hours during working hours.

Grievance: A student who believes that a decision affecting some aspect of their university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student

Petitions and Grievances, Section 4. When in doubt, please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity to avoid committing an academic offence, and to take responsibility for their actions. [Check the Office of Academic Integrity for more information.] A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate associate dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline. For typical penalties, check Guidelines for the Assessment of Penalties.

Appeals: A decision made or penalty imposed under Policy 70, Student Petitions and Grievances (other than a petition) or Policy 71, Student Discipline may be appealed if there is a ground. A student who believes they have a ground for an appeal should refer to Policy 72, Student Appeals.

Note for students with disabilities: AccessAbility Services, located in Needles Hall, Room 1401, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with AccessAbility Services at the beginning of each academic term.

All coursework and software code is subject to checking for collusion and plagiarism and the use of AI tools using Turn-It-In.

Turnitin.com: Text matching software (Turnitin®) may be used to screen assignments in this course. Turnitin® is used to verify that all materials and sources in assignments are documented. Students' submissions are stored on a U.S. server, therefore students must be given an alternative (e.g., scaffolded assignment or annotated bibliography), if they are concerned about their privacy and/or security. Students will be given due notice, in the first week of the term and/or at the time assignment details are provided, about arrangements and alternatives for the use of Turnitin in this course.

In case we need to move online for some part of the course: Course materials and videos provided by the instructors must not be shared on social media or otherwise distributed in any form (including sharing links to them). They are for your own personal use while studying at the University of Waterloo only, and are subject to copyright and intellectual property laws, and university privacy policies. By taking part in the course, you agree not to share this material or any links to it to anyone outside the course without instructor agreement. Please discuss with the instructors if you have concerns.

Auditors (those not enrolling for credit), if any, are required complete all course elements (including project proposal) except for the final project report.

Compassionate Accommodation: If you are facing challenges that are affecting more than one course contact the Associate Chair Graduate Studies. They will review your case and coordinate a reasonable and fair plan in consultation with appropriate others (for example: instructors, Department Graduate Studies Committee, Chair, AccessAbility Services, Engineering Counselling services, Registrar's Office)