RO47013 - Control in Human Robot Interaction
Practical Assignment 3 (PA3)
Design & Human Factors in HRI

Instructors

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Learning objectives

In this practical assignment, you will explore how human-robot interaction impacts human factors and vice-versa. You are expected to be able to:

- **LO1.** Create a human-robot interaction system to solve a specific problem.
- **LO2.** Use a human-factors study to evaluate the effectiveness of human-robot interaction (or use human-robot interaction to research human factors).
- **LO3.** Create a concise presentation and relay research findings to your peers.

Motivation for this practical assignment

Unlike the previous assignments (**PA1** and **PA2**), this assignment is open-ended and exploratory. You are encouraged to use any of the knowledge obtained in the Master Robotics program as a tool for analysis of the benefits of human-robot interaction. You are free to improvise with the analysis outside the metrics and methods suggested below. Do not be afraid to explore and even fail to observe the hypothesized effects. Remember, even a rejected hypothesis is still a valid result that you can discuss, critically reflect on, and present.

Here are a few examples of scenarios:

- Use human demonstrations to synthesize autonomous robotic skills for welding.
- Create a system to account for human ergonomics during the painting of a nuclear reactor through teleoperation.
- Teleoperate a swinging crane to bring containers through a cluttered and windy port.
- Cut tissue along one straight line in an eye surgery simulator.
- Teleoperate a micro-robot subjected to Brownian motion for biomechanical testing.
- Improve human steering performance using shared control.
- Teleoperate a robot on Mars to reach for a crack (of a specific width) in the wall of the living quarters from an initial position as fast as possible to stop the leakage.

We expect you to:

1) Find a problem to solve. Write a research question and form a hypothesis about which condition would perform best.
2) Create a human-robot interaction system and design experimental protocol with different conditions (e.g., with or without haptics / unilateral vs bilateral / trajectory learning with kinesthetic guidance or teleoperation / viscous vs non-viscous environment). The conditions can either be based on:
    - the type of controller/feedback, in which case the task is constant (e.g., type of haptic guidance, methods for trajectory learning, etc…),
    - the type of task, in which case the controller is constant (e.g., sawing vs polishing, random perturbations, unstable environment, etc…).
3) Implement and run the experiment to collect data. For example, you can measure the speed (objective metric), the accuracy (objective metric), the intuitiveness (subjective questionnaire, learning curves), etc…
4) Analyze the collected data, and create a visualization to draw conclusions on the best approach to solve the problem. Comparing two or more conditions may include statistical analysis.
5) Present findings. Prepare a 10-minute presentation about your work and results.

Assessment / Grading

Unlike in the previous assignments, where only the code and report were assessed, the **PA3** assessment is based on your work (codes included) and a presentation. Each group should submit a zip file containing at least all your codes and the presentation file (ppt or pdf). If you have videos of experiments, either include them in the ppt file, or include them separately inside the zip file in case you are submitting the presentation in pdf. Since the presentations are spread over the week, we want to make sure everyone has the same amount of time to work on the assignment. Therefore, you are not allowed to change your presentation after the submission. There is a maximum of **10 points** in this assignment. Both the work and the presentation will be assessed using the rubric provided below.

PA3 Assessment Rubric (RO47013: Control in Human Robot Interaction)

Criteria/Score	Excellent (10-9)	Good (8-7)	Acceptable (6)	Insufficient (>5)
CONTENT				
Originality of idea	• Uses the learned material to create an innovative application • Excellent research question	• Reproduces some of the complex applications seen during the lectures • Solid research question	• Reproduces some of the straightforward applications seen during the lectures • Okay research question	• Idea is not clear • Trivial research question
Execution & setup	Setup with extensive features (e.g., in code, visualisation, haptics, etc.)	Setup with solid features (e.g., in code, visualisation, haptics, etc.)	Setup with simplistic features (e.g., in code, visualisation, haptics, etc.)	Setup does not support the idea
Performance metrics	Completely appropriate for the idea (e.g., also w.r.t. research question)	Appropriate for the idea (e.g., also w.r.t. research question) but would not capture all the aspects	Appropriate for the idea (e.g., also w.r.t. research question) but would not capture one or more key aspects	Not appropriate for the idea (e.g., also w.r.t. research question)
Experimental protocol	• Appropriate experimental conditions • Appropriate experimental task • Appropriate isolation of undesired factors	Two appropriate aspects	One appropriate aspect	No appropriate aspects
PRESENTATION				
Introduction	• Clear overview of the context • Explanation of how physical feedback impact the task • Clear and focused research question	• Overview of the context • Explanation of physical feedback • Reasonably clear and focused research question	• Overview of the context • Some Explanation of physical feedback • Research question present	• No overview of the context • Lacking explanation of the impact of physical feedback • No research question
Methods	• Clear rationale • Clear description of the techniques used • Clear description of the protocol • Informative illustration(s) of the experimental task	• Appropriate Rationale • Complete description of the techniques used • Description of the protocol • Clear illustration(s) of the experimental task	• Rationale is present • Somewhat complete description of the techniques used • Short description of the protocol • illustration(s) of the experimental task	• no rationale • Poor description of the techniques used • No description of the protocol • No illustration of the experimental task
Results	• Clear description of the data analysis • Clear and informative plots • Use of statistics	• Appropriate description of the data analysis • Clear plots • Use of statistics	• Description of the data analysis • Plot presents • Use of statistics	• No description of the data analysis • No plots • No statistics
Discussion	• Interpretation of the results • Actionable recommendations	• Interpretation of the results • Recommendations	• Interpretation of the results • Recommendations	• No interpretation of the results • No recommendations