INSTITUT DES SYSTEMES INTELLIGENTS ET DE ROBOTIQUE
OFFRE DE STAGE

Fiche de stage

Sujet du stage : Developing computational models of perspective taking for human-robot interaction

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Durée du stage : 5 à 6 mois

Niveau d'études souhaité : Master 2 / Ecole d'ingénieurs

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Date limite de dépôt de la candidature : 10/01/2022

Description du stage

Context:

Most collaborative robots will be dropped in human environment where they will have to accomplish missions. They will be engaged in interaction with human individuals concerned by these missions. Mutual understanding and coordination of goals, intentions, plans and actions are required to achieve these missions. In this work, we will focus on interaction involving robot motion generation such as arm movement or navigation and in particular we aim to generate legible motions.

Legible motions, also known as transparency through motion, are used by robots to communicate their intent to human observers [Dragan-2013]. By drawing inspiration from research on how humans interpret observed behaviors as goal-directed actions, the state-of-the-art approaches propose algorithms aiming to maximize human inference of a goal given to a robot motion. The approaches refer to "action-to-goal" interpretation of actions, which requires to explicitly taking into account the human observer in the loop.

In order to generate efficient legible motions, robots require a model of the human, which is called inverse human model. Building such models require perspective-taking abilities. Being able to place yourself "in someone else's shoes" requires several sets of abilities such as the ability to understand the visuo-spatial experience of another agent; to infer her thoughts and beliefs; and to infer her emotions/feelings [Schilbach-2013]. These abilities are referred to as spatial, cognitive and affective perspective-taking, respectively [Hamilton-2014] and are

investigated by means of experimental protocols that are now extensively used in cognitive sciences (e.g., [Sebanz-2006], [von Mohr-2020]. Despite the importance of these models, there is still no computational model able to compute on-line inverse models of perspective taking. In addition, it is not clear how humans will benefit from legible motions generated by such computational models.

Objectives:

The main objectives of this work are (i) to design experiments inspired by cognitive science allowing to evaluate perspective-taking during human-robot interactions (generation of robot motions), (ii) develop computational models able to predict perspective-taking preferences of human observers, (iii) develop metrics allowing to assess the benefit of computational inverse human models for the generation of legible robot motions.

This work will exploit methodologies and models of human-robot interaction, machine learning and cognitive science. The experiments can be carried out with the PEPPER or Franka Emika robots. Motion capture will be used to assess human reactions to robot motions.

The main steps are:

- Development of collaborative tasks such as cooperative drawing, teaching tasks requiring technical skills, or else object manipulation (see the “Give me the wrench scenario” [Trafton-2005] or spatial referring [Dogan-2020])
- Design a study (including a control condition) to evaluate and collect multimodal data about perspective taking. Self-assessment, scales and questionnaires will be used to qualify human preferences.
- Development of machine learning based models able to detect human preferences.
- Experimental evaluation of models for the generation of legible motions.

Skills: Python, Machine Learning, Robotics, and Cognitive Science

References:

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[von Mohr-2020] Von Mohr M, Finotti G, Ambroziak KB, Tsakiris M. (2020) Do you hear what I see? An audio-visual paradigm to assess emotional egocentricity bias. Cogn Emot. 34, 756-770.