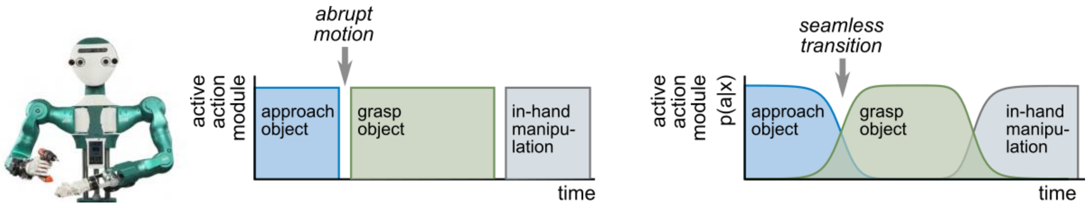
A step towards natural robot behavior: designing seamless actions blending

Manipulation tasks can naturally be decomposed in sequences of actions, e.g., a picking task consists of two phases, namely approaching the object, and grasping it. Humans effortlessly transition from one action to the other while featuring smooth and continuous motions throughout the whole manipulation task. In contrast, although robots may be able to execute complex individual skills such as grasping, their motions still feature abrupt changes when transitioning between subsequent actions. In addition to increased acceleration and torque commands leading to possible damage in the long run, this lack of seamlessness remains one of the obstacles to achieve human-like natural robot behavior.



To achieve human-like behavior, ARMAR-6 has to transition smoothly between actions.

This project aims at endowing robots with close-to-human action-sequencing capabilities while performing various manipulation tasks. In order to account for the diverse learning modalities that are better adapted to acquire specific robotic skills (e.g., neural networks for image-based inputs, or movement primitives for fast motion planning), we will consider each action as a black box providing a set of task-space commands. Given a sequence of these commands, we aim at defining a blending framework to smoothly transition between actions.

This leads to several challenges that we will tackle in this project. First, the structure of task space commands may greatly vary from one action to the next: indeed, actions may feature - among others - position, orientation, force, or manipulability commands, as well as combinations of them. Therefore, the first challenge is to define a structure that can encode the aforementioned command modalities, while taking into account their different characteristics, e.g., geometries, or constraints. The second challenge consists of designing a blending mechanism that achieve seamless transitions between actions. To do so, we will study how to adapt the parameters of the aforementioned command structures during the transition phase, either by learning them from human demonstrations, or by optimizing them according to the task at hand.

In this project, you will work with the humanoid robot ARMAR-6 both in simulation and in real-world scenarios, as well as several robotics and machine learning tools:

- ArmarX (C++, Python): armarx.humanoids.kit.edu
- Pytorch (Python): https://pytorch.org/

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