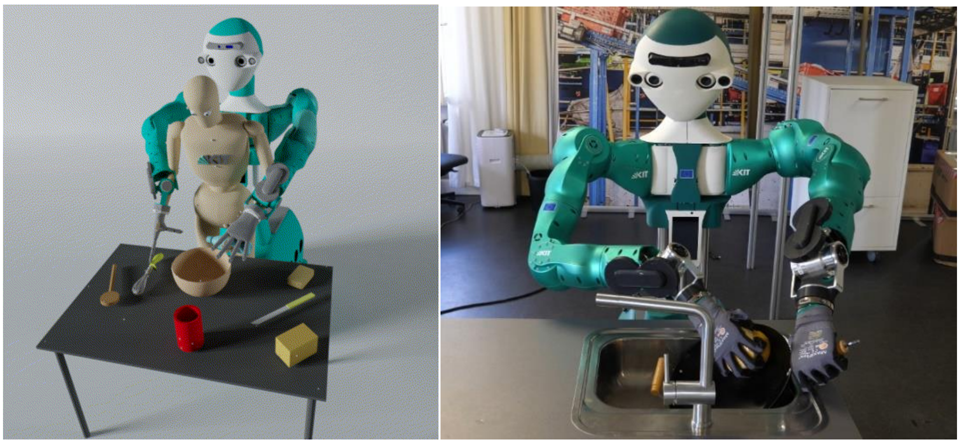
Unified Bimanual Controller with Various Coordination and Compliance Adaptation Strategies



In our daily activities, human can do dexterous manipulations by switching from unimanual to bimanual activities fluently and changing the arm coordination and compliance adaptation strategies in a robust and smooth way. For example, when you clean up a dinner table, you can stack plates with both arms independently and then lift up a heavy pile of plates and place them into a sink. You first keep the muscles of both arms stiff and estimate the dynamic properties instantly and adapt your compliance accordingly to safely interact with the environment.

To achieve such dexterous manipulation skills and maintain safe interaction in human-centric environment, we aim at developing a unified real-time bimanual control system, which possesses a pool of arm coordination strategies and a pool of compliance adaptation strategies. It communicates with high-level task models and memory system to fetch the proper controller configurations, motion representations based on the perception information.

In this work, firstly, you will investigate how to categorize and mathematically formulate the coordination strategies, i.e. the control laws for symmetric and asymmetric bimanual coordination. Secondly, you will implement the coordination and compliance adaptation strategies in the unified bimanual control framework, which has interface to the high-level components. The goal of the project is to realize a unified controller that underpins most of the kitchen (household) activities and copes with visual and force feedbacks to keep safe interactions during the task execution.

Relevant research questions include:

- How to categorize and mathematically formulate the various arm coordination strategies?
- How to achieve compliance adaptation with force and visual feedbacks? And how to integrate gravity estimation and compensation into compliance adaptation?

This work will be implemented as a unified real-time controller in ArmarX and tested on the humanoid robot ARMAR-6. The following software are required:

- ArmarX (C++): armarx.humanoids.kit.edu
- MPLib (C++): a library of movement primitives

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