IthruI
Towards Better Robot Manipulation: Improvement THRoUgh Interaction

Marie Curie International Outgoing Fellowship
FP7-PEOPLE-2013-IOF-628854

Objectives: This project aims to investigate how learning can be used to improve and expand the manipulation abilities of a robot-out-of-a-box. Robots, like all other gadgets, will come out of their box with a certain amount of built-in knowledge that will enable them to perform a set of tasks with a reasonable performance at the push of a button. The project argues that, the robot-out-of-a-box should come with both (1) a set of built-in capabilities that would enable it to solve manipulation tasks in unstructured human environments, as well as (2) the learning ability to extend and improve, and with guarantees not to hinder, its capabilities through its interactions over the lifetime of the robot with minimal user effort. Moreover, foreseeing that manipulation capabilities of robots will remain inferior to those of humans in the near future, and the project aims to extend their capabilities of the robots through simple forms of communications that enable them to “manipulate humans”.

Work performed: This project studied how the built-in competence of the robot can be improved through (1) its interaction with its (inanimate) environment and (2) its interaction with humans. The work towards the first objective was carried out at the Robotics Institute of Carnegie Mellon University (CMU), USA during the first phase of the project and was resumed at the Middle East Technical University later. Specifically, after reviewing the related literature, we have analyzed the robot control architectures built with the SMPA (Sense-Model-Plan-Act) paradigm, and proposed nine different strategies that can improve the performance of a built-in behavior developed within the SMPA paradigm using sensorimotor data collected from previous interactions. These strategies identified the main modules in use at these architectures and aimed to improve the performance of these behaviors by tapping and changing the data transmitted in between, changing the parameters of these modules, or by replacing them through learned modules.

We have implemented and evaluated three of these strategies on two different robot platforms and have shown that they would improve the built-in behaviors. Specifically, first, we have developed and implemented a strategy that uses the sensory signals during the manipulation action to detect abnormalities in execution on the HERB robot platform at CMU. Second, we have implemented two strategies that added learned-offset values to the initial and goal positioning of the objects to improve the accuracy of the pick-and-place behavior on the iCub platform at METU.

We argued that modeling a robotic manipulation action can be best achieved by learning a map from the initial pose of an object to its final pose using data collected from the actual interactions of the manipulator with the object. We developed a method for regressing the final orientation of an object from its initial orientation after a manipulation action, without solving the full SO(3) (a.k.a. orientation space) regression problem using assumptions that typically hold in robotic manipulation

Towards the second objective, we have proposed a unified framework in which robots can ‘’manipulate’’ humans in a similar way they manipulate inanimate objects in their environment. We have shown that this could be implemented through the inclusion of communicative behaviors, such as gaze and pointing, and would enable the robot to achieve tasks that are beyond its immediate capabilities. Our human-robot interaction studies on the iCub platform has shown that the interaction can be improved over time through its interaction with the humans.

Expected final results and potential impact: The robot-in-a-box vision promotes robots as gadgets. This project investigated how built-in manipulation skills can be improved through data recorded from interactions and how robots can integrate human communication in a similar framework that would allow them to “manipulate” humans.

The interaction through improvement framework identified a number of strategies that can piggy-back the already-available capabilities of robot platforms and improve them over time as well as a unified framework for improving human-robot interaction. These contributions have the potential to provide add-on values to the collaborative robot manipulation platforms that are gaining track recently.

Contact details:
Contact: Assoc.Prof. Erol Sahin
Address: KOVAN Research Lab., Computer Engineering Dept., Middle East Technical University, Dumlupinar Bulvari,06800, Ankara, Turkey.
E-mail: erol@metu.edu.tr
Web: http://kovan.ceng.metu.edu.tr/~erol/
IthruI Webpage URL: http://kovan.ceng.metu.edu.tr/projects/ithrui/