

Video Description: Demonstrating Adaptive Tool-Use with an Anthropomorphic Service Robot

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Tool-use is one of the most complex object manipulation abilities of humans and robots. It necessitates a variety of perception as well as control capabilities. In this video, we present our approaches to implementing tool-use with anthropomorphic service robots.

In robotic tool-use, the robot manipulates an environmental object, i.e. the tool, to change the state of another object. To successfully operate the tool, the robot needs to know the position of the tool as well as the affected object. It has to utilize the tool through adequate control strategies.

In our work, we use a personal service robot with an anthropomorphic upper body [2]. The robot is equipped with two 7 degree-of-freedom (DoF) arms. It perceives tools using an RGB-D camera mounted on the robot's head.

For this robot, we implemented several examples of tool-use that integrate perception and control [1]. Tools used by humans are specifically designed for the human body. Hence, we also propose to adapt the tools themselves to the robot "body" by equipping them with special handles that can provide the necessary stability for the robot's grasp. We propose a variety of RGB-D perception approaches that allow for segmenting tools, estimating their tips, and tracking their pose. We also establish shape correspondences between similar tools to transfer tool-use skills from one tool to another.

We demonstrate tool-use by our service robot publicly at RoboCup@Home competitions. The demonstrations have been important contributions to winning the competitions at RoboCup 2013 and at the RoboCup German Open 2014.

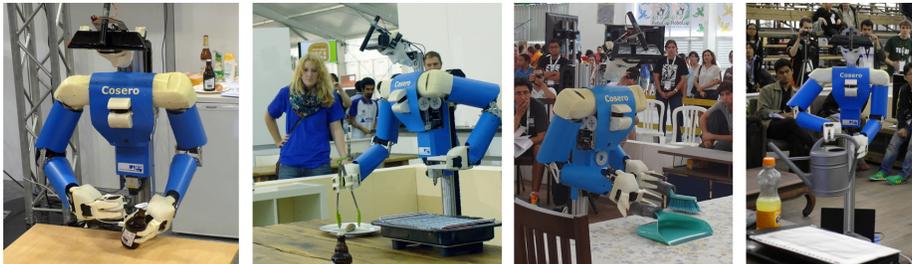


Fig. 1. Examples of tool use by our robot Cosero.

References

1. Jörg Stückler and Sven Behnke. Adaptive tool-use strategies for anthropomorphic service robots. In *Proceedings of 14th IEEE-RAS International Conference on Humanoid Robots (Humanoids)*, 2014.
2. Jörg Stückler, David Droschel, Kathrin Gräve, Dirk Holz, Michael Schreiber, Angeliki Topalidou-Kyniazopoulou, Max Schwarz, and Sven Behnke. Increasing flexibility of mobile manipulation and intuitive human-robot interaction in RooboCup@Home. In *RoboCup 2013: Robot World Cup XVII*, volume 8371 of *Lecture Notes in Computer Science*, pages 135–146. Springer, 2014.