

Robot Factors: An Alternative Approach for Closing the Gap in Human versus Robot Manipulation

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ROBOT FACTORS

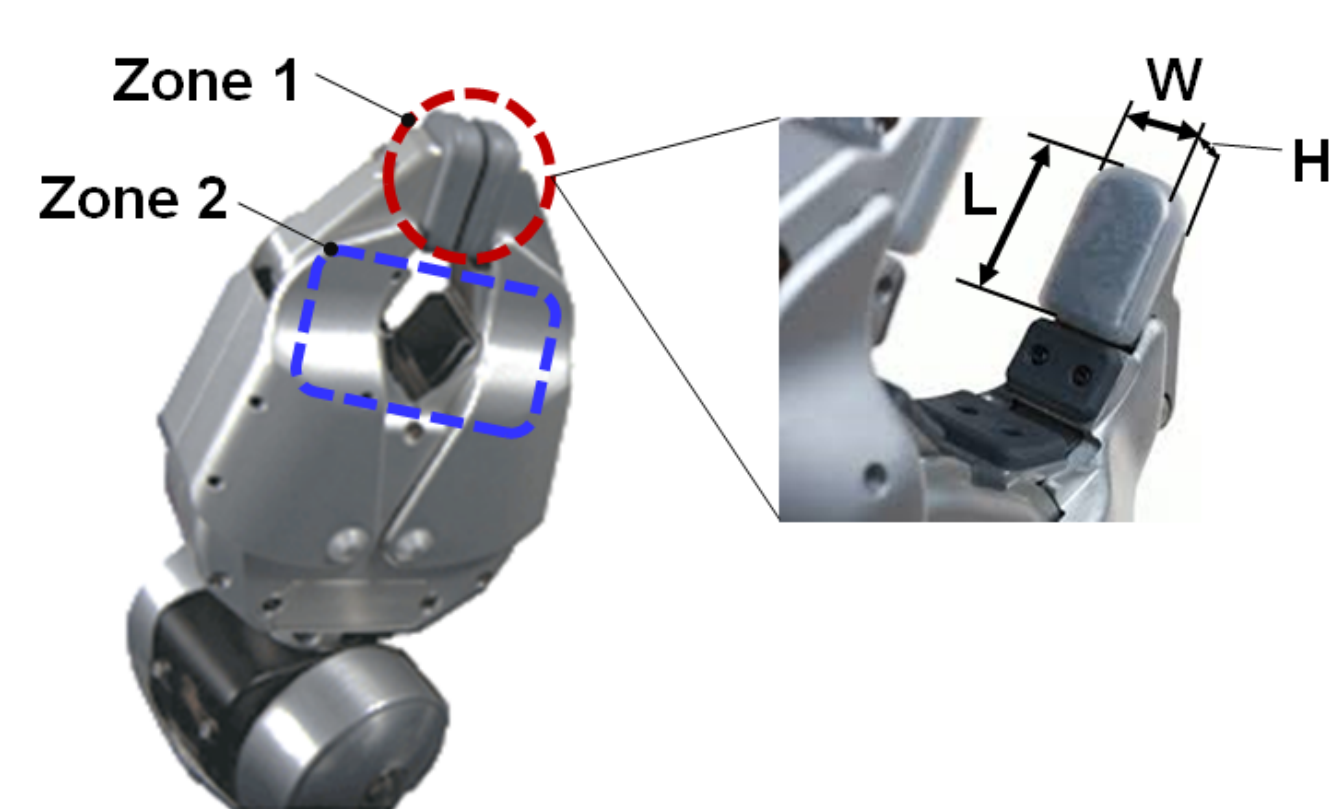
Robots can reliably perform useful tasks in environments specifically structured for them (e.g. factories). Human environments are designed based on **human factors**, which creates additional challenges for non-human-like robots. We argue for modifying human environments based on **robot factors** as a practical method for achieving robust operation in human environments. Such modifications need to be *low-cost*, *easy to install*, and *not disruptive* to human workflow.



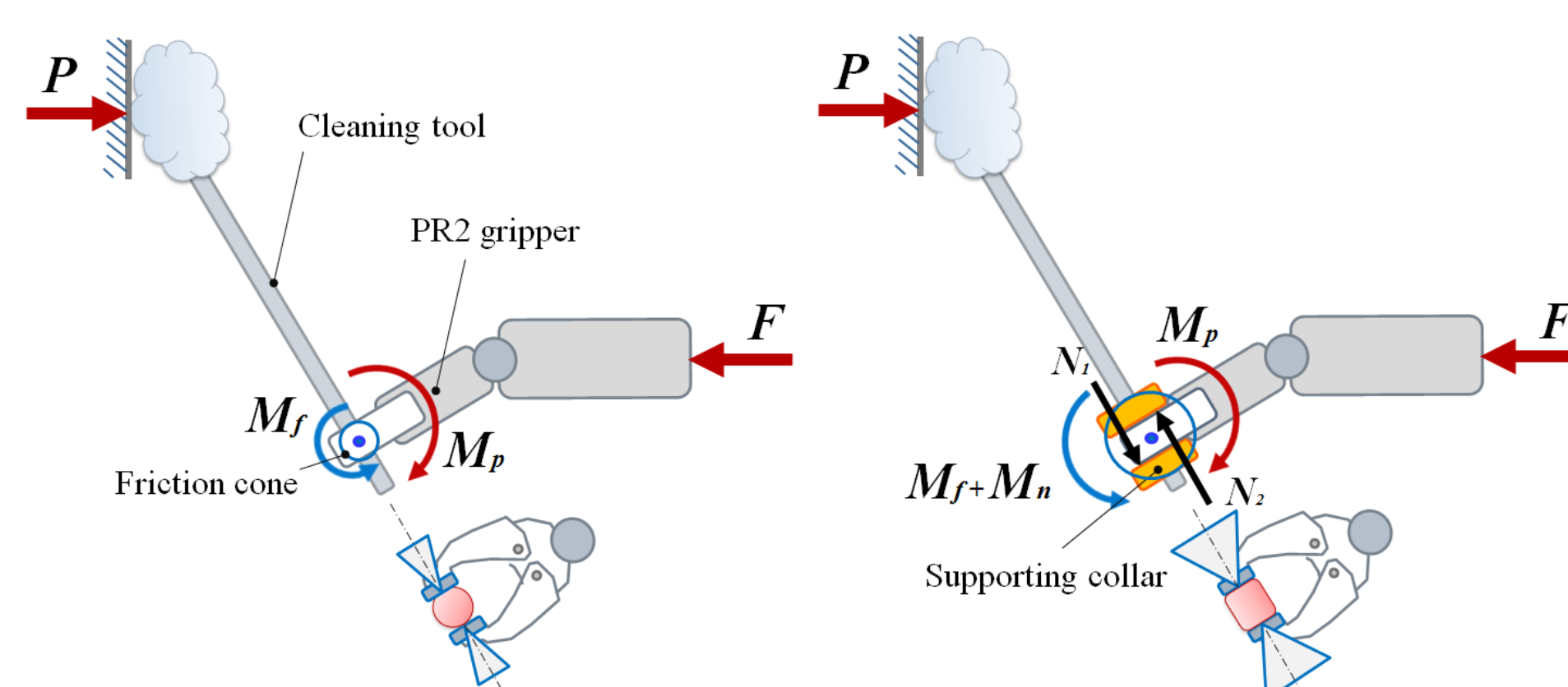
Examples of modifications made based on robot factors (Nguyen et al., 2008, 2013) (Hawkins et al., 2012) (Beetz et al., 2011)

GRIPLE

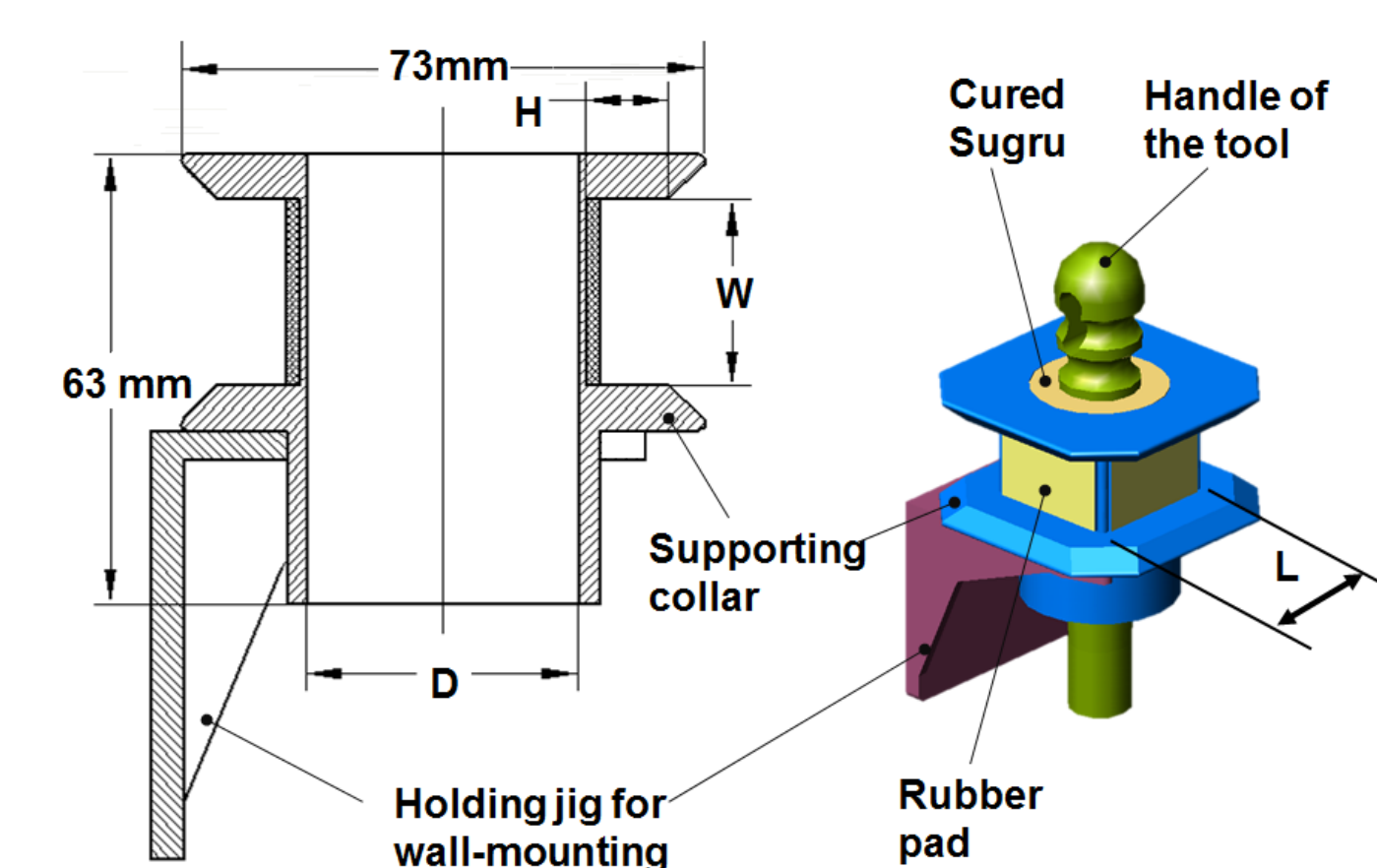
Manipulation of human tools is particularly challenging because of the mismatch between grippers and tool handles. We design a universal tool attachment, Griple (gripper handle), to help perceive, grasp, apply, and place everyday cleaning tools with handle.



The gripper of a PR2 robot. Zone 1 for precision grasps, Zone2 as throat capacity and for power grasps.

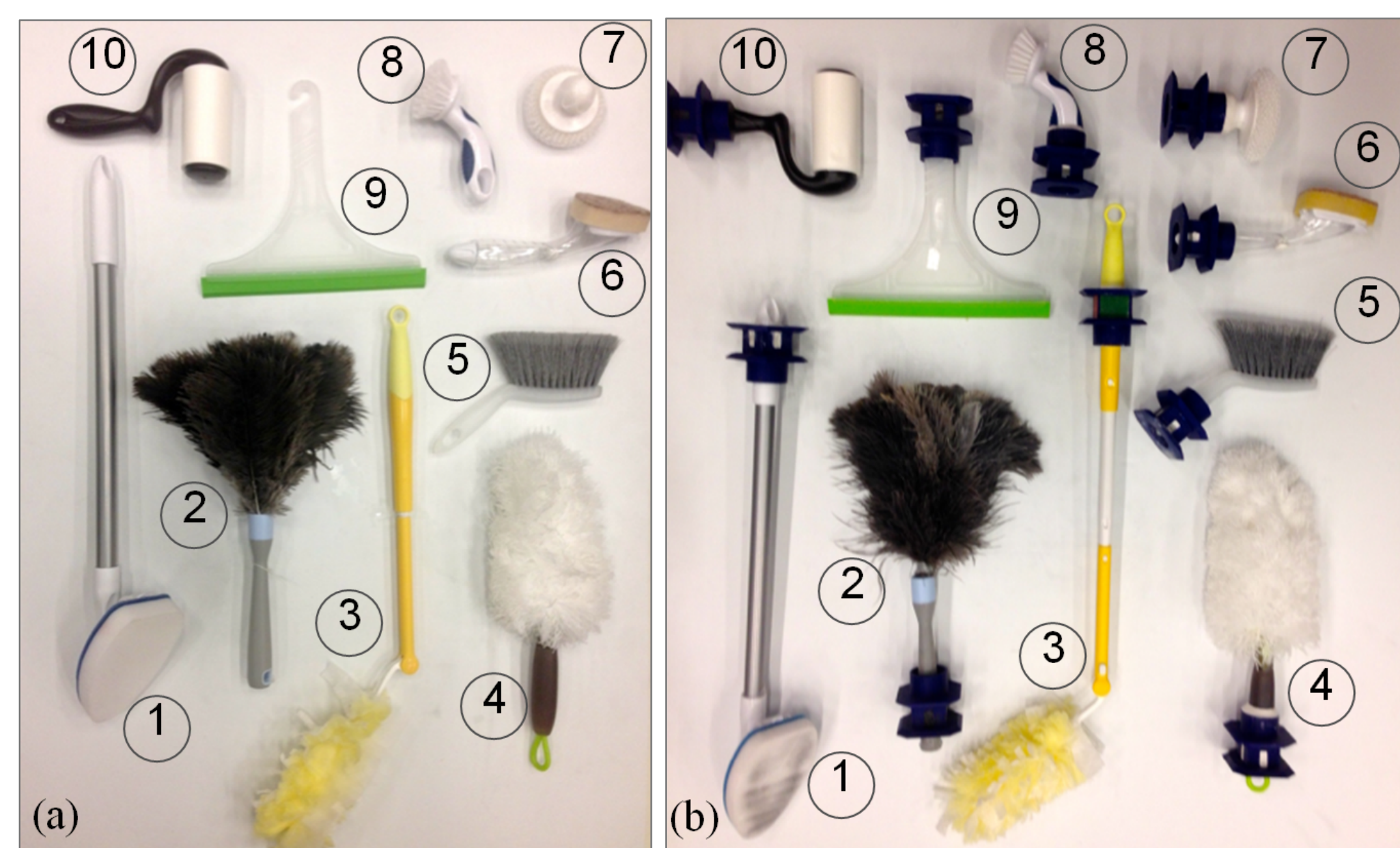


Force/torque requirements for tool use. With original tools the robot cannot overcome torque at contact point due to limited friction.

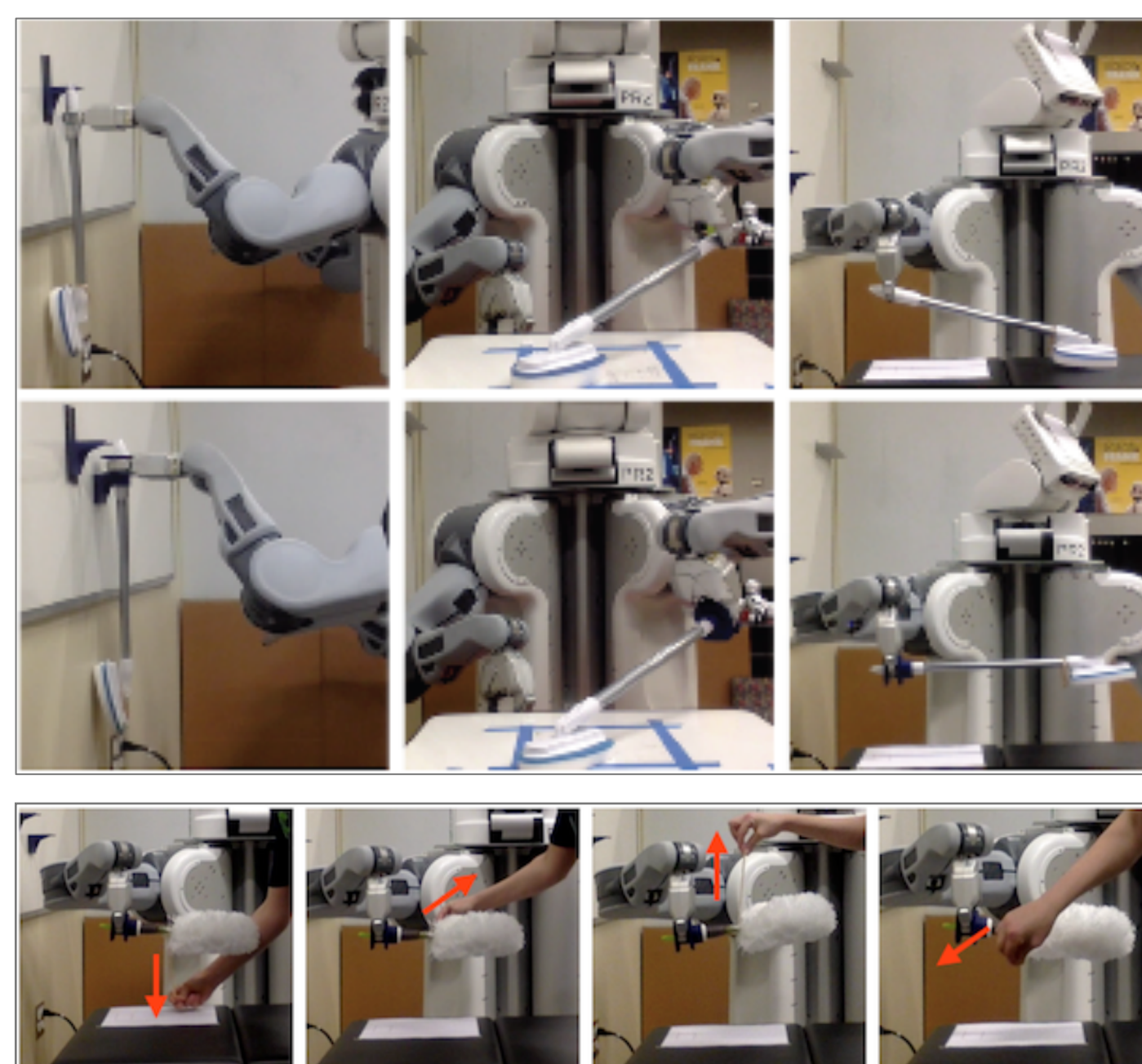


*Design of the Griple that satisfies force/
torque requirements with increased contact
surface and support collars.*

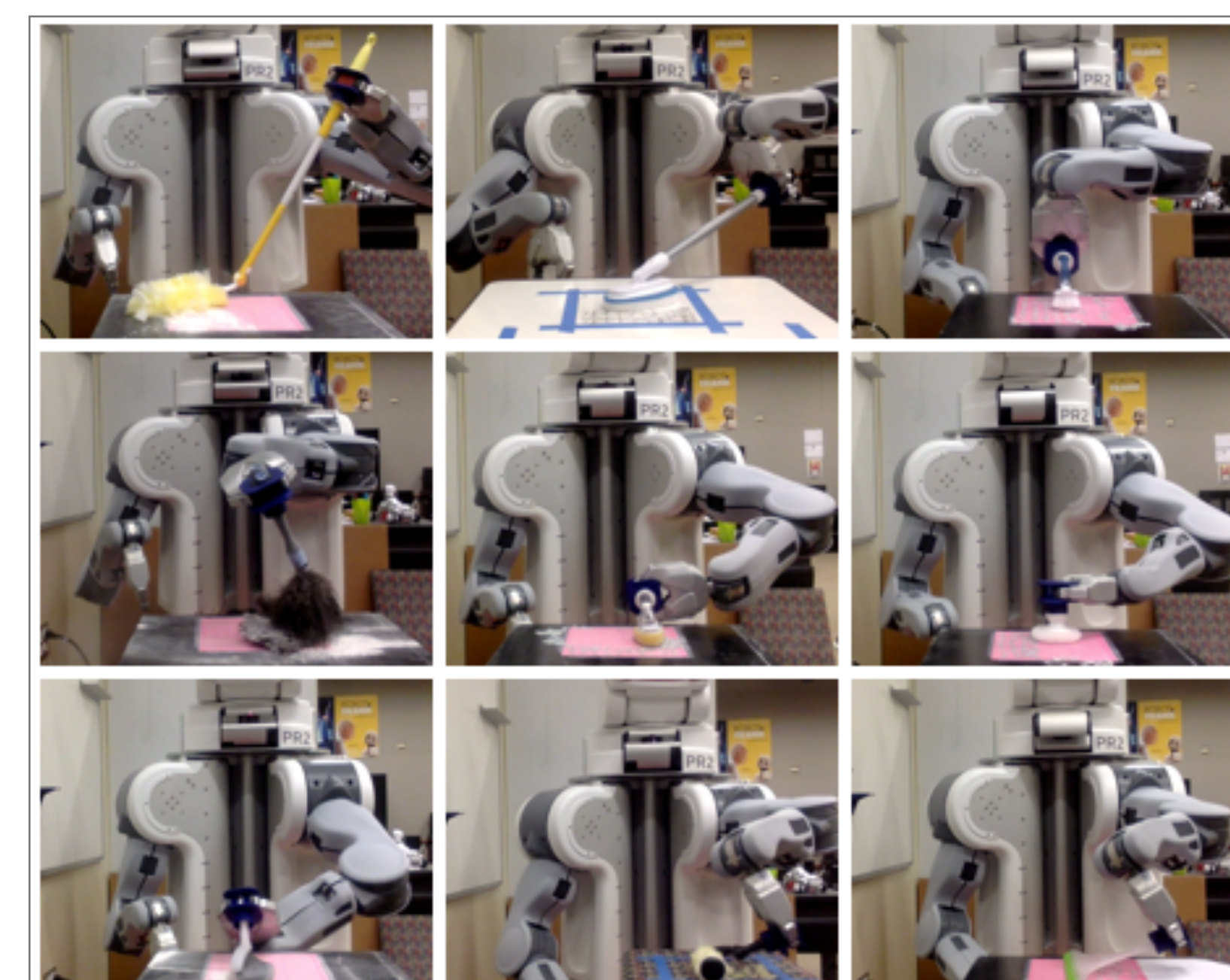
ROBOTIC CLEANING EXPERIMENTS



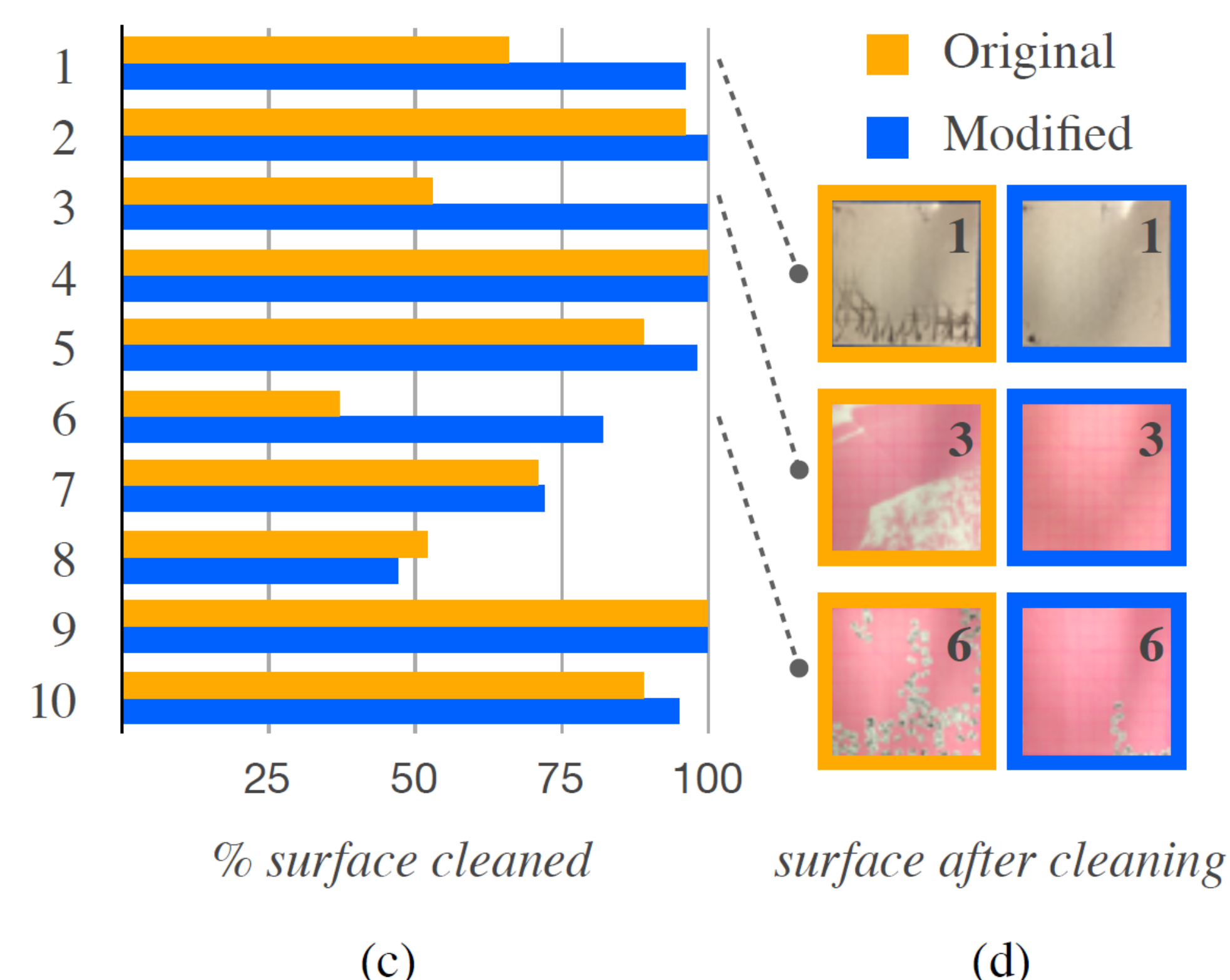
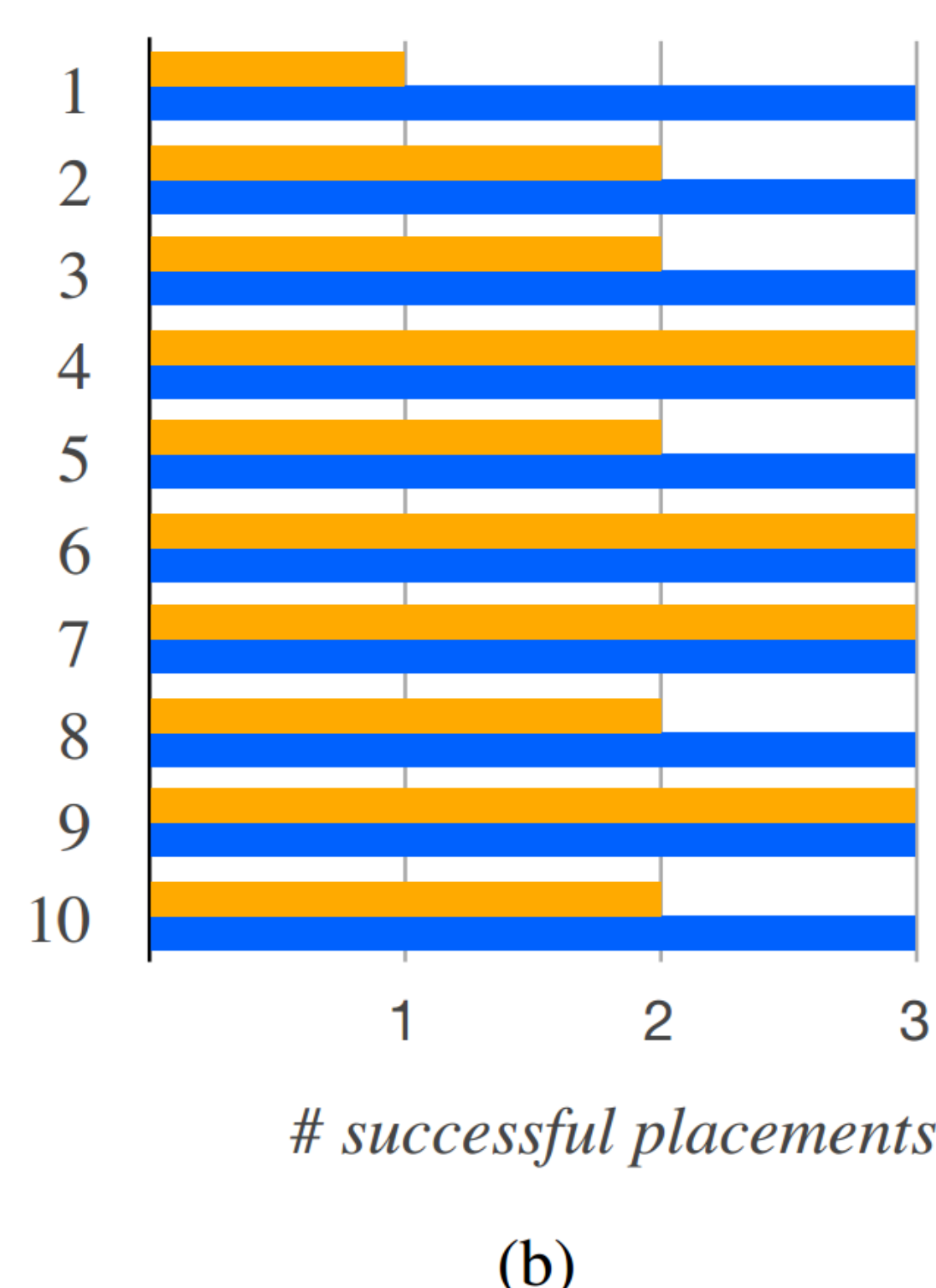
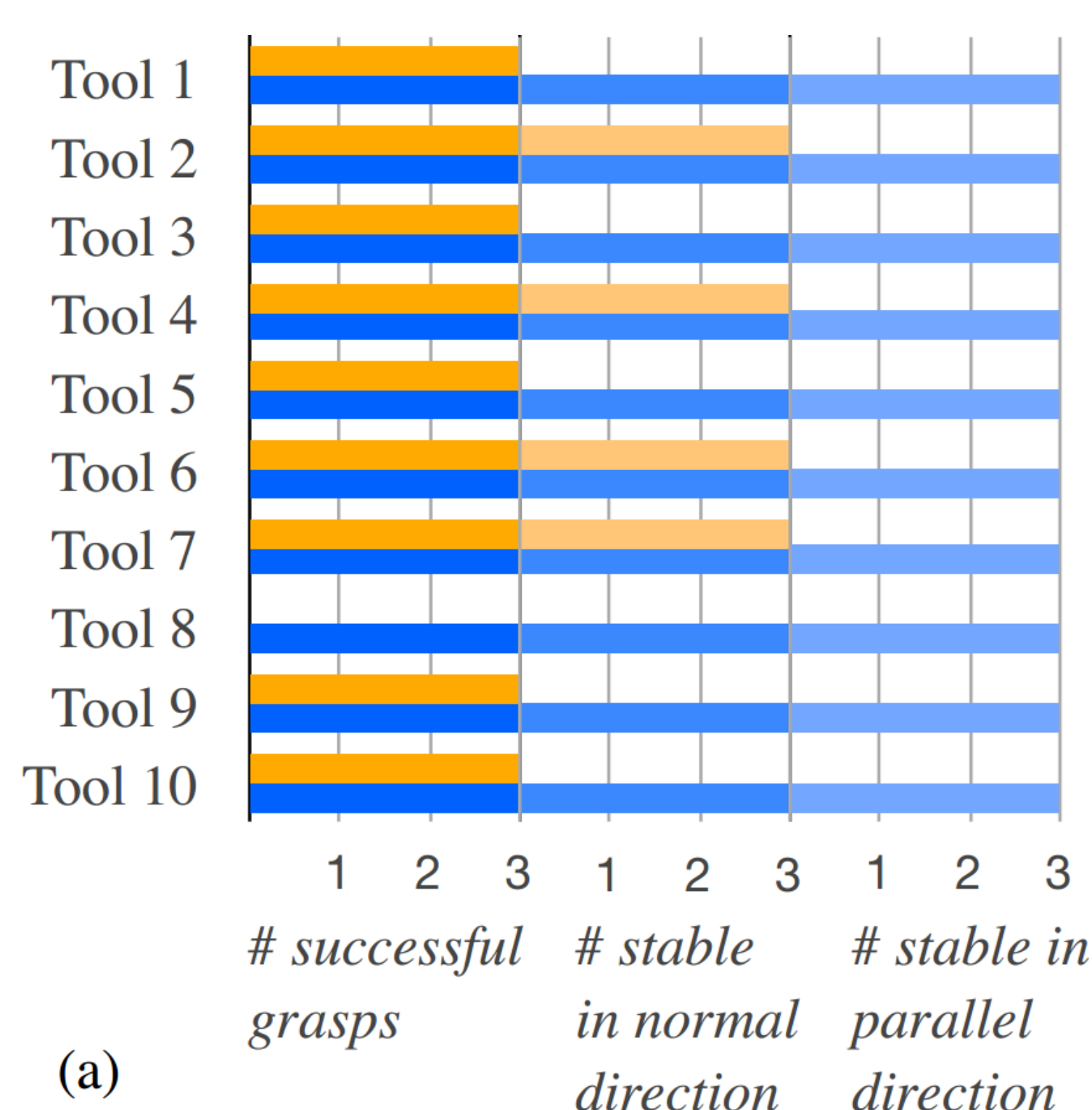
Original and Modified tools: Sponge (Tool 1), Dusters (Tools 2, 3, 4), Sweeper (Tool 5), Scrubbers (Tools 6, 7, 8), Squeegee (Tool 9), Lint remover (Tool 10)



(Top) Snapshots from experiments evaluating Griple in grasping, applying, and placing tools. (Bottom) Snapshots from grasp stability tests.



Snapshots from tool application tests with different tools.



Griple provides more successful and stable grasps, more successful placements and better cleaning performance