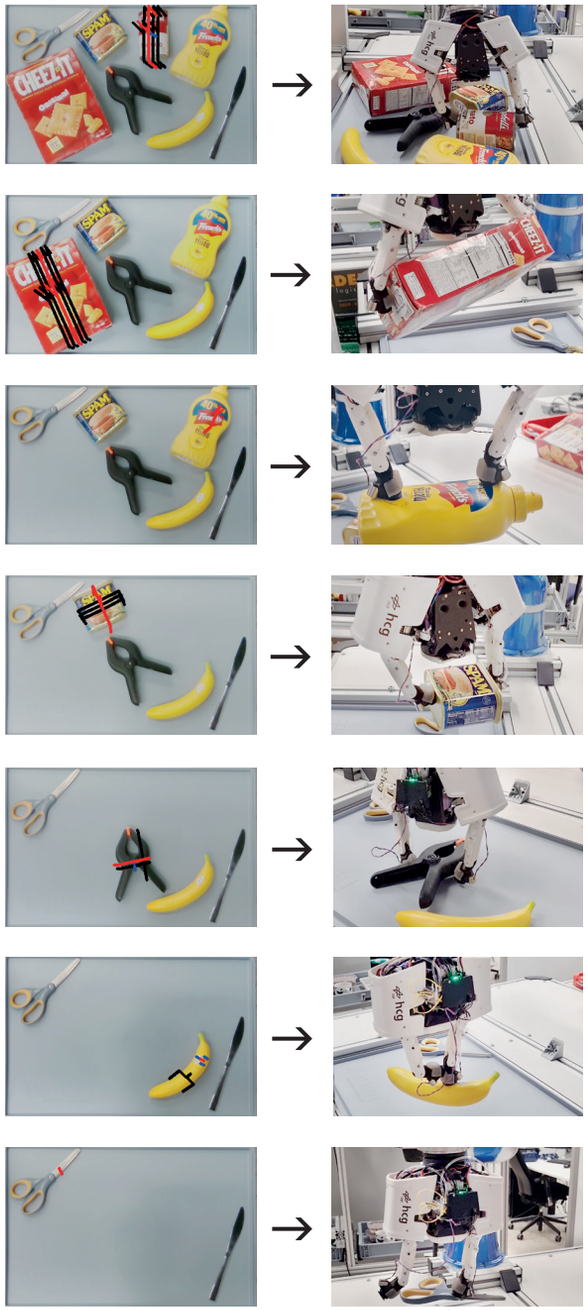

DLR at a glance

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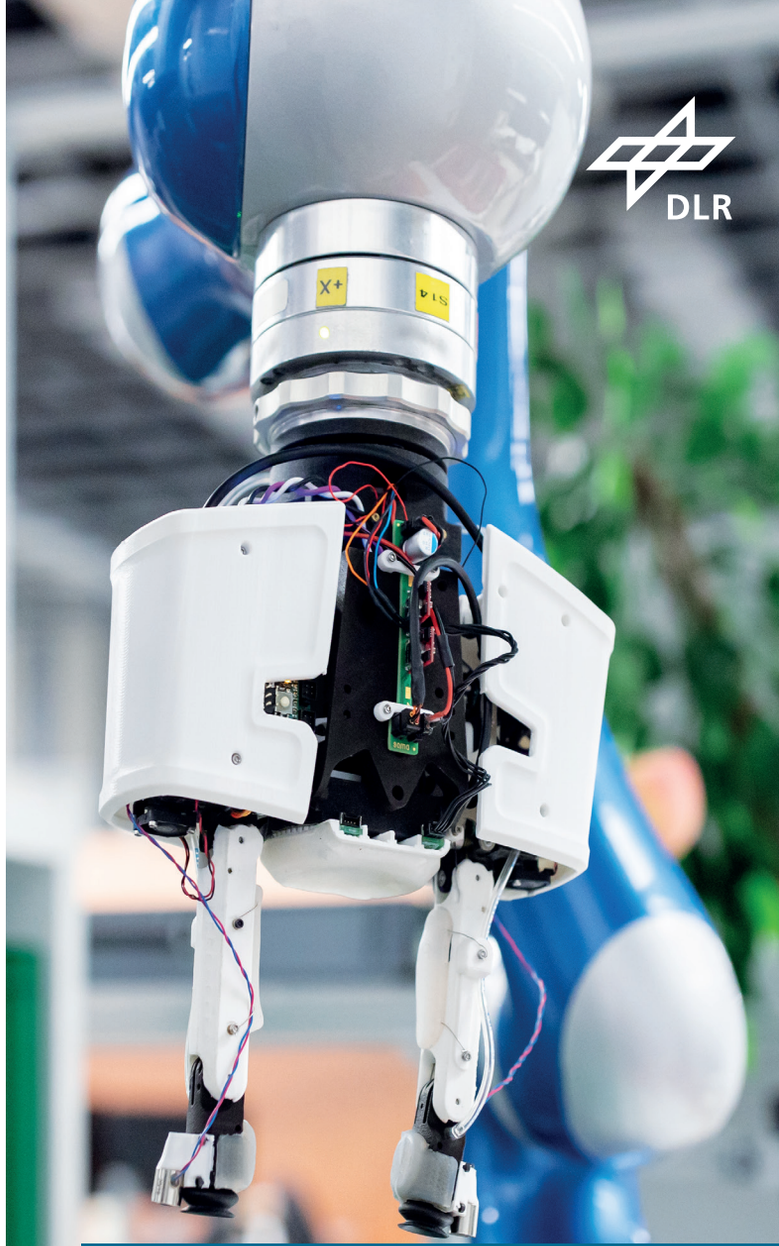


DLR

HCG

Hybrid **C**ompliant **G**ripper

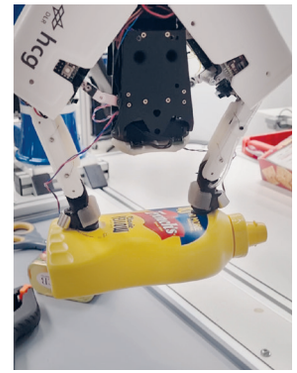
Hybrid Compliant Gripper (HCG)

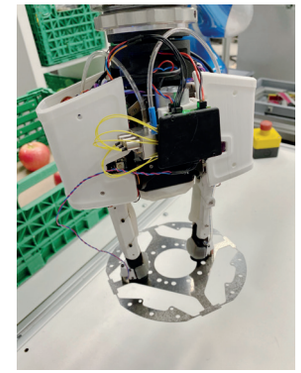
The Hybrid Compliant Gripper was designed for logistic tasks, namely for bin picking problems. Especially when the bin is full, grasping an object might be difficult for traditional grippers, as the fingers must be placed in the limited spaces between the objects. This is challenging also for object perception and grasp planning. Suction grippers can easily grasp objects from the top, but are not able to grasp objects with non-smooth surfaces. The HCG features special fingertips with suction cups to grasp objects from the top, or retrieve the objects as a normal gripper using two-fingers grasps.

Different benchmark scenarios in a logistic application, compare success rate between DLR CLASH and HCG

The HCG is based on the thumb modules of the DLR CLASH (Compliant Low cost Antagonistic Servo Hand). Two extra degrees of freedom were added to tilt the finger modules, which enhances the grasp span to over 250mm.

Furthermore, with the suction cups, new ways of in-hand manipulation are possible for the hybrid gripper. The changeable fingertips allow also to integrate sensorized fingertips or electro-magnetic fingertips for special tasks.





HCG technical data:	
Size:	170 x 120 x 240 mm³
Weight:	800 g
Degrees of freedom:	8
Payload:	20 N per Finger
Power supply:	12-30 V
Joint velocity:	360 °/s
Features:	• Flexible base structure for shock absorption • Tiltable finger modules for large grasp span • Changeable fingertips with sensing capabilities • Vacuum pump with ventils • Two vacuum sensors • Changeable suctions cups
Grasp span:	up to 250 mm

Multimodal grasp planning

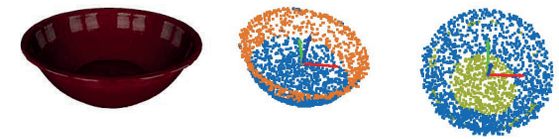
The proposed model-based grasp planner allows the hybrid gripper to use three grasping modalities: two fingers for parallel-jaw grasp, suction cup(s) for suction grasp, and an elector-magnet for grasping magnetic objects. The pipeline starts from the output of a neural network that can detect the 6D pose of the objects involved in the scene based on a single RGB image. For each detected object, its bounding box is computed, and the possible parallel-jaw and suction grasps are generated for each object's face pointing towards the camera.

Depending on the setting, the relative pose of the objects, and the gripper properties, the feasible grasps are extracted from the candidate grasps by filtering them using the object's visibility and checking whether there is enough space for the fingers without colliding with the other components of the scene. Then the grasp with the highest probability of success is selected depending on several criteria, such as the number of object collisions.

The algorithm also allows the use of two suction cups mounted at the end of the articulated fingers to pick up two different objects at the same time. The use of two suction cups can also be beneficial for picking up a single heavy object, or an object bigger than the maximum grasp span of the gripper.

A parallel pipeline that exploits another neural network is employed for magnetic grasp. It identifies and segments metallic objects, and after postprocessing, the algorithm provides the centroid of a metallic area as a candidate grasping point.

For unknown rigid objects, a model-free grasp planner is used. It takes object point cloud and uses a deep neural network to output a segmentation mask that, for each point, indicates whether or not the point is suitable for a grasp with fingers or a suction grasp. The grasp modality favored by most points is executed.



Object | Possible 2 finger grasp | Possible suction grasps