

GRASPING AND RELEASING PROTOCOL

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Purpose	To assess the robot or human hand's repeatability when grasping and releasing an object. The protocol assesses the hand by tracking sensorized object motion during grasp and release.
Task Description	A chosen sensorized object is periodically grasped and released on a rigid surface with the assessed hand for both a power and a precision type grasp.
Setup Description	List of objects and their descriptions: The cylinder, cube, and sphere from the modular, sensorized object collection, equipped with appropriate motion capture markers/sensors, are used in the protocol.
	Initial and target poses of the objects: The initial pose of the objects should be chosen and marked on a flat, rigid surface. A template can be found in http://newdexterity.org/benchmarking/ . The protocol is performed for each object separately, where the object center is initially aligned with the marked position. The orientation of the objects should be kept constant for all initial placements. The target pose is identical to the initial pose.
	Description of the manipulation environment: If using optical motion capture equipment, the space should be free of clutter and reflective surfaces. If using magnetic motion capture equipment, the environment should be free of large metallic objects or magnetic fields (excluding the hand).
Robot/Hardware/Software/Subject Description	Targeted robots/hardware/software: Any hand or gripper may be used in the protocol. A robot or setup capable of offsetting the hand or gripper vertically should be available. There are no constraints on the control software of the hand - a package that maximizes performance should be used.
	Initial state of the robot/hardware/subject with respect to the setup: The assessed robot hand or gripper should be mounted on the setup or robot capable of vertical offset. The assessed hand should initialize roughly 10cm above the object center.
	Prior information provided to the robot (if applicable): Prior to the manipulation operation, the robot hand should be programmed and tested with the object to ensure robust grasping. The robot does not need to know the object model or properties.
Procedure	Repeat following steps for each object: <ol style="list-style-type: none"> 1) Place the object and assessed hand into their defined initial positions. 2) Begin object motion data recording with the chosen motion capture system. 3) Lower the hand and grasp (power or pinch grasp) the object. 4) Raise the hand by 10cm. 5) Lower the hand and release the object. 6) Stop the system and motion recording.
Execution Constraints	A power type grasp and a precision type grasp is used in the protocol, although if the hand is unable to perform one of the two the feasible grasp type should be selected and used for all objects.

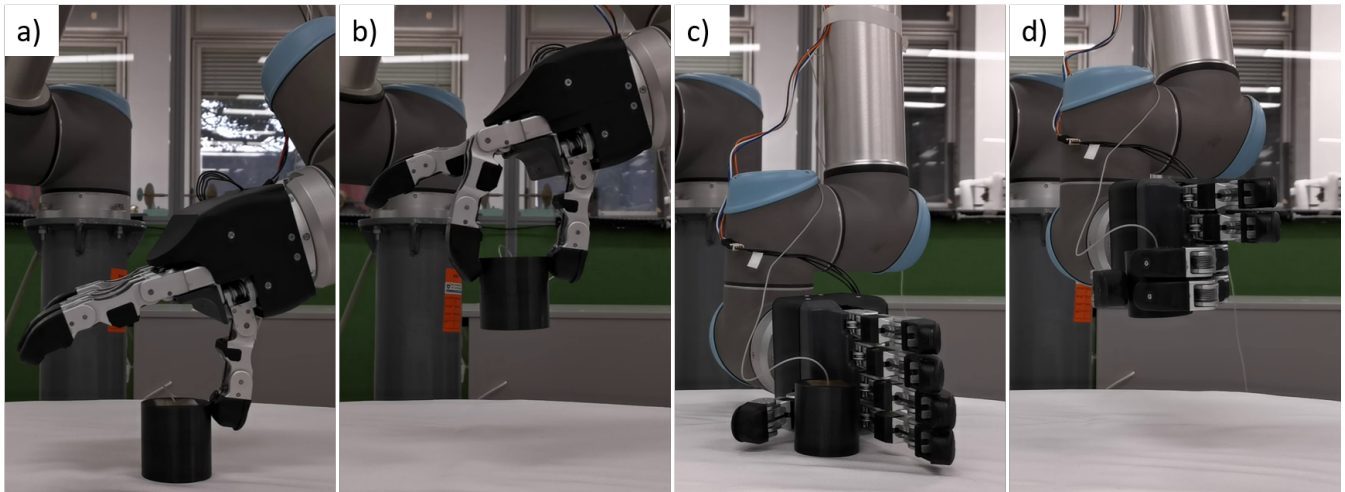


Fig. 1. Grasping and releasing assesses how repeatably and accurately a manipulator is able to release an object during a precision grasp (subfigures a and b demonstrate the precision grasp experiment), and a power grasp (subfigures c and d demonstrate the power grasp experiment).