BIMANUAL CLOTH MANIPULATION PROTOCOL – FOLDING

Reference No / Version	RAL-SI-2020-P19-0832_2-V1.0 (for the latest versions of the protocol, please refer to https://ral-si.github.io/cloth-benchmark/#resources or http://www.ycbbenchmarks.org/protocols-and-benchmarks/)
Authors	Irene Garcia-Camacho*, Martina Lippi*, Michael C. Welle, Hang Yin, Rika Antonova, Anastasiia Varava,Julia Borras, Carme Torras, Alessandro Marino, Guillem Alenya, Danica Kragic
Institution	KTH Royal Institute of Technology, Institut de Robòtica i Informàtica Industrial, CSIC-UPC
Contact information	igarcia@iri.upc.edu, mlippi@unisa.it
Purpose	Assess the ability of a bimanual robotic system to manipulate small and big towels to fold them.
Task Description	This task consists in taking a towel and folding it in half's 3 times, on a table. The task considers 2 different sized towels and different starting configurations of the towel.
Setup Description	<u>List of objects and their descriptions:</u> **Towel:** Two sizes for the towel are considered: - Small towel **[st]**: IKEA towel Hären 30×50 cm or 30×30 cm, available at the link https://www.ikea.com/jp/en/catalog/products/30163571/ Sizes depends on the country; - Big towel **[bt]**: IKEA towel Hären 50×100 cm or 40×70 cm, available at the link https://www.ikea.com/gb/en/p/haeren-hand-towel-white-80163583/ **Table:** Any table with the following dimensions can be used: - Width: $[70, 80]$ cm; - Length: $[120, 185]$ cm; - Height: $[72, 75]$ cm.
	<u>Initial and target poses of the objects:</u> The following starting configurations must be considered for the objects. **Towel:** Four possible starting configurations are defined: - Two pre-grasped points (**[pg2]**). Cloth is pre-grasped at two corners (unfolded); - One pre-grasped point (**[pg1]**). Cloth is pre-grasped at one point; - Towel flat on the table (**[ft]**). The cloth is not pre-grasped and is placed flat on the table with as less

	wrinkles as possible; • Towel random on the table (**[cr]**). Cloth is crumpled on the table. **Table:** it can be placed everywhere in the robots workspace. To complete the task, the towel must be folded three times in half. Each folding can be evaluated individually.
	<u>Description of the manipulation environment:</u> The location of the towel on the table for the flat and crumpled cases is not relevant for the task, as long as it is in workspace of the robots. However, the authors need to report in the benchmark results if their system needs to object to be in a particular location. There is no clutter in the environment.
Robot/Hardware/Software/Subject Description	<u>Targeted robots/hardware/software:</u> Any bimanual setup with grasping capabilities can be employed
	<u>Initial state of the robot/hardware/subject with respect to the setup:</u> Robots may be located anywhere with respect to the table.
	<u>Prior information provided to the robot:</u> All the objects and table dimensions are known by the robots.
Procedure	1. Setup the camera to record the manipulation and a timer. 2. Prepare setup and the manipulation environment: table, chosen towel and robot. Place the towel in the chosen initial configuration. 3. Execute the manipulation recording the results and measuring time. 4. If manipulation is successful, take the measurements on the folded towel the evaluate the quality function. 5. Write execution time and measurements in the table. Repeat steps 2-5 five times.
Execution Constraints	Any strategy adopted must be the same for the 5 executions.