# DUAL-ARM CLOTH MANIPULATION PROTOCOL – FOLDING

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| Purpose | Assess the ability of a dual arm 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><br>**Towel:** Two sizes for the towel are considered:<br>• Small towel **[st]**: IKEA towel Häre̊n $30 \times 50$ cm or $30 \times 30$ cm, available at the link https://www.ikea.com/jp/en/catalog/products/30163571/ Sizes depends on the country;<br>• Big towel **[bt]**: IKEA towel Häre̊n $50 \times 100$ cm or $40 \times 70$ cm, available at the link https://www.ikea.com/gb/en/p/haeren-hand-towel-white-80163583/<br>**Table:** Any table with the following dimensions can be used:<br>• Width: $[70, 80]$ cm;<br>• Length: $[120, 185]$ cm;<br>• Height: $[72, 75]$ cm. |
| | <u>Initial and target poses of the objects:</u><br>The following starting configurations must be considered for the objects.<br>**Towel:** Four possible starting configurations are defined:<br>• Two pre-grasped points (**[pg2]**). Cloth is pre-grasped at two corners (unfolded);<br>• One pre-grasped point (**[pg1]**). Cloth is pre-grasped at one point;<br>• 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;<br>• Towel random on the table (**[cr]**). Cloth is crumpled on the table. |

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| | **Table:** it can be placed everywhere in the robots workspace.<br>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><br>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 reach of the robot. It can be placed at the optimal location of the arm workspace. However, the authors need to report in the benchmark results if their system needs to object to be in a particular location.<br><br>There is no clutter in the environment. |
| Robot/Hardware/Software/Subject Description | <u>Targeted robots/hardware/software:</u><br>Any dual-arm setup with grasping capabilities can be employed |
| | <u>Initial state of the robot/hardware/subject with respect to the setup:</u><br>Robot may be located anywhere with respect to the table. |
| | <u>Prior information provided to the robot:</u><br>All the objects and table dimensions are known by the robot. |
| Procedure | 1. Setup the camera to record the manipulation and a timer.<br>2. Prepare setup and the manipulation environment: table, chosen towel and robot. Place the towel in the chosen initial configuration.<br>3. Execute the manipulation recording the results and measuring time.<br>4. If manipulation is successful, take the measurements on the folded towel the evaluate the quality function.<br>5. Write execution time and measurements in the table.<br>Repeat steps 2-5 five times. |
| Execution Constraints | Any strategy adopted must be the same for the 5 executions. |