BIMANUAL MANIPULATION PROTOCOL (TASK 2)

Reference No / Version	RAL-SI-2020-P19-0836_2-V1.0 (for the latest versions of the protocol, please refer to: https://www.epfl.ch/labs/lasa/sahr/benchmark/)
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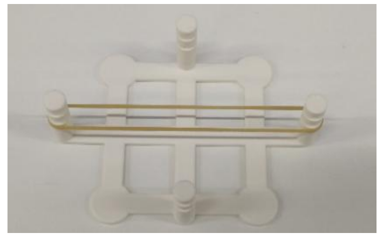
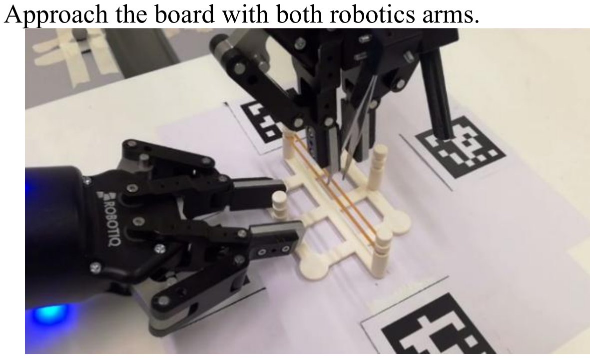
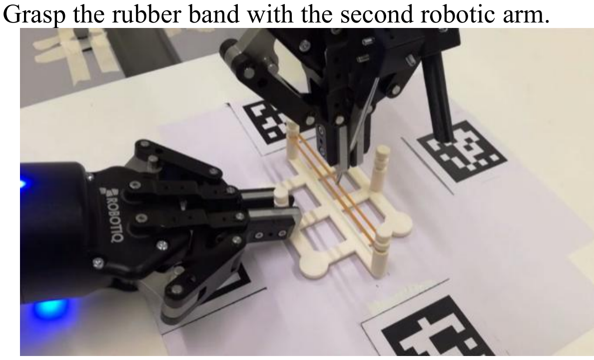
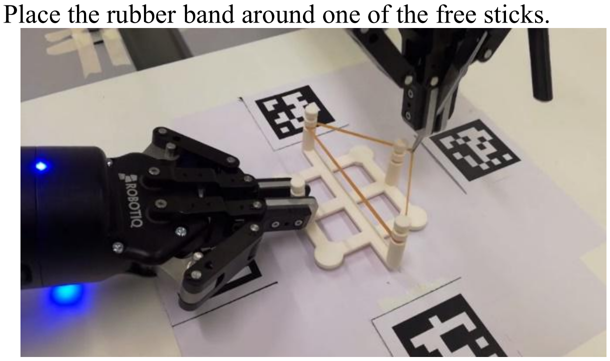
Purpose	Assess the motion planning and/or learning performance of a multi-arm system performing insertions.
Task Description	Manipulation of deformable rubber-band with the help of tools to form a specified shape.
Setup Description	List of objects and their descriptions: *Rubber-band* : elastic band. *3D-printed board with sticks* : CAD model of a board with 4 pegs is provided. 3D-printable with FDM technology (suggested) or a technology with 1mm precision minimum. *Tweezers* : used to insert the band into place on the board. Note that it may be sufficient to use a standard robotic gripper to replace the tweezers. We hence let users decide if they want to opt for that solution or they wish to have a tweezer mounted on the robot's end-effector. Whichever solution is chosen, we set only as constraint that the tool at the end-effector have the following characteristics: (a) only two legs, and (b) only one translational degree of freedom; hence it can only "pinch".
	Initial and target poses of the objects and tools: Two robotic arms with tweezers/grippers as end effector.
	Description of the manipulation environment: Board placed on a flat surface inside the workspace of all robots, rubber-band placed on the board at initial position/shape.
Robot/Hardware/Software/Subject Description	Targeted robots/hardware/software: Two robotic arms, with at least 4 DoFs. Force/Torque sensing not required, but likely useful. Object tracking through computer vision (the participants need to use the one provided by the benchmark) One RGB camera feedback for OFL or ONL approaches (see Benchmark for description of four possible approaches)
	Initial state of the robot/hardware/subject with respect to the setup: Initial state of the robotic arms may be any non-singular state which allow to reach the board. One robotic arm already grasping the rubber band with the tweezers/gripper. Initial position of the board is chosen by the user.
	Prior information provided to the robot: Initial location of the tweezers is considered to be known a-priori, as they are grasped by the robotic arms.

<table>
<tr>
<td>Procedure</td>
<td>Starting from the configuration in the figure:

1. Approach the board with both robotics arms.


2. Grasp one stick on the board with one robotic arm to stabilize it.
3. Grasp the rubber band with the second robotic arm.


4. Place the rubber band around one of the free sticks.


5. Repeat steps 3-4 to place the rubber around the other stick.
6. Repeat steps 1-5 for 5 times total.
7. Repeat steps 1-6 for 3 different board orientations in total, chosen by the user in the workspace of both robots.
(Please refer to the supplementary video for examples of steps 1-5).</td>
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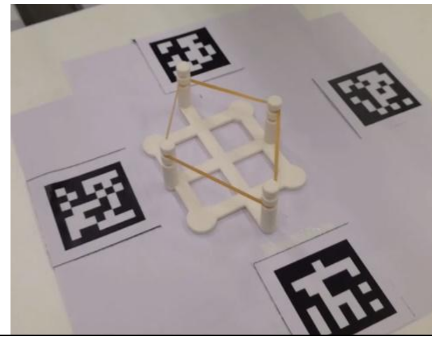
	Final configuration: 
Execution Constraints	None.