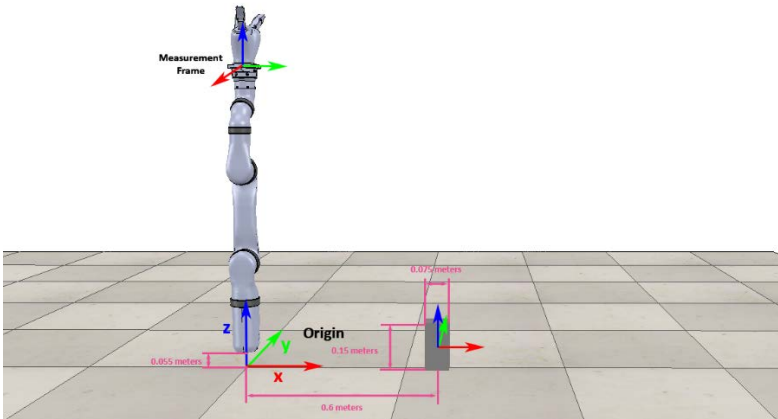


## Simulated Robotic Manipulation Protocol

Reference No / Version	RAL-SI-2020-P[19-0842]_9-V1.1 for the latest versions of the protocol please refer to <a href="https://research.csiro.au/robotics/manipulation-benchmark/">https://research.csiro.au/robotics/manipulation-benchmark/</a>
Authors	J. Collins, J. M <sup>c</sup> Vicar, D. Wedlock, R. Brown, D. Howard and J. Leitner
Institution	CSIRO/QUT
Contact information	jack.collins@data61.csiro.au
Purpose	A prehensile manipulation task to replicate the movement of a plastic cuboid. This will assess the environmental interactions of a robotic manipulator in addition to the kinematic motion of the arm.
Task Description	The task involves a 9 second sequence of movements, the movement promotes the cuboid to rock onto an edge, almost falling onto its long side. A video of the task being performed by the real world manipulator is available at <a href="https://research.csiro.au/robotics/manipulation-benchmark/">https://research.csiro.au/robotics/manipulation-benchmark/</a>
Setup Description	<p><u>List of objects and their descriptions:</u></p> <ul style="list-style-type: none"> <li>Flat laminated surface</li> <li>Stratasys ASA 3D printed cuboid (<math>0.075 \times 0.075 \times 0.15</math> meters), a mesh file of the cuboid is available at the benchmark website. Weight = 0.14 Kilograms</li> </ul> <p><u>Initial and target poses of the objects:</u></p> <p>The initial configuration of the cuboid within the scene can be seen in Figure 1 and Figure 2. The cuboid is standing tall, its base centered 0.6 meters away from the origin with the reference frame seen in the figures.</p> <p><u>Description of the manipulation environment:</u></p> <ul style="list-style-type: none"> <li>Temperature: 17.5°C</li> <li>Relative Humidity: 43%</li> </ul>
Robot/Hardware/Software/Subject Description	<p><u>Targeted robots/hardware/software:</u></p> <ul style="list-style-type: none"> <li>Kinova Mico<sup>2</sup> 6DOF Manipulator, sensor mounting bracket, Robotiq FT300 sensor, gripper mounting bracket and KG-3 Gripper. URDF of robot provided.</li> </ul> <p><u>Initial state of the robot/hardware/subject with respect to the setup:</u></p> <ul style="list-style-type: none"> <li>Robot is fixed 0.055 meters above origin and the base centered.</li> <li>The base frame of the robot should align with the origin frame of the simulator as demonstrated in Figure 1 and Figure 2.</li> </ul> <div style="text-align: center;">  </div>

*Figure 1: Side orthographic view of scene setup with offsets and reference frames.*

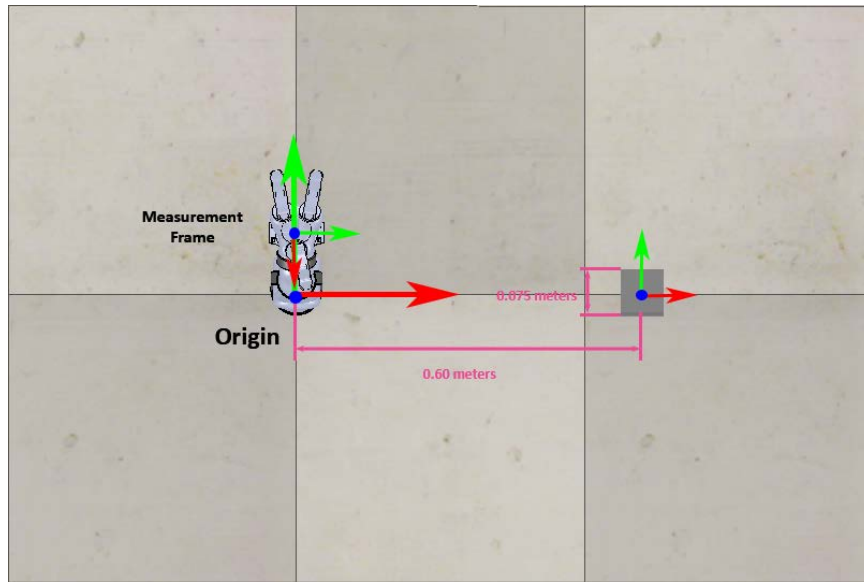


Figure 2: Top view of scene setup with offsets and reference frames.

- The robot begins with the following joint rotations (0,180,180,0,0,0)
- Gripper remains fully open.
- Control of the robot is at 10Hz using a Proportional controller to set joint velocities.
  - The gain of the P controller is 4
  - The controller requires the current joint rotations from the robot.

Prior information provided to the robot:

Nil

Procedure

The following is a sequence of rotations and times the robot has to achieve the desired configurations. The proportional controller is supplied with this information to elicit the desired movements of the manipulator.

0. (0,180,180,0,0,0) at start
1. (-5,166,290,91,0,0) for 3 seconds
2. (-2,140,265,91,0,0) for 3 seconds
3. (-2,130,200,91,0,0) for 3 seconds

Execution Constraints

- The configuration of the robot and the proportional velocity controller are fixed parameters that are not user definable.