**Robotic Disassembly/Assembly NIST Task board 1 BENCHMARK**

|  |  |
| --- | --- |
| Reference No / Version  URL | RAL-SI-2020-B-1 [Benchmarking Protocols for Evaluating Small Parts Robotic Assembly Systems]-V1.0 |
| <https://www.nist.gov/el/intelligent-systems-division-73500/robotic-grasping-and-manipulation-assembly/assembly> |
| Authors | Kenneth Kimble1, Karl Van Wyk2, Joe Falco1, Elena Messina1, Yu Sun3, Mizuho Shibata4, Wataru Uemura5, Yasuyoshi Yokokohji6 |
| Institution | 1National Institute of Standards and Technology (NIST), 2NVIDIA, 3University of South Florida, 4Kindai University, 5Ryukoku University, 6Kobe University |
| Contact information | [Joseph.falco@nist.gov,](mailto:Joseph.falco@nist.gov,) [Kenneth.kimble@nist.gov](mailto:Kenneth.kimble@nist.gov) |
| Adopted Protocol | RAL-SI-2020-P [Benchmarking Protocols for Evaluating Small Parts Robotic Assembly Systems]-V1.0  Kenneth Kimble1, Karl Van Wyk2, Joe Falco1, Elena Messina1, Yu Sun3, Mizuho Shibata4, Wataru Uemura5, Yasuyoshi Yokokohji6  1National Institute of Standards and Technology (NIST), 2NVIDIA, 3University of South Florida, 4Kindai University, 5Ryukoku University, 6Kobe University |
| Scoring | Disassembly Score Sheet:  Start Time: End Time:   |  |  |  |  | | --- | --- | --- | --- | | Item | Removed  (2 points) | Placed in Kit Tray  (1 point) | Sub-Total | | Small Gear | 2 | 1 |  | | Medium Gear | 2 | 1 |  | | Large Gear | 2 | 1 |  | | Rod 4 mm | 2 | 1 |  | | Rod 8 mm | 2 | 1 |  | | Rod 12 mm | 2 | 1 |  | | Rod 16 mm | 2 | 1 |  | | Bar 4 mm x 4 mm x 300 mm | 2 | 1 |  | | Bar 8 mm x 7 mm x 300 mm | 2 | 1 |  | | Bar 12 mm x 8 mm x 300 mm | 2 | 1 |  | | Bar 16 mm x 10 mm x 300 mm | 2 | 1 |  | | BNC Connector | 2 | 1 |  | | Waterproof Connector | 2 | 1 |  | | DSUB Connector | 2 | 1 |  | | USB Connector | 2 | 1 |  | | RJ45 Connector | 2 | 1 |  | | M4 Nut | 2 | 1 |  | | M8 Nut | 2 | 1 |  | | M12 Nut | 2 | 1 |  | | M16 Nut | 2 | 1 |  | | Note: Max Score = 60 Total Score | | |  |   Example of start and end of a disassembly trial with 100% completion:    Start End  Assembly Score Sheet:  Start Time: End Time:   |  |  |  |  |  | | --- | --- | --- | --- | --- | | Item | Inserted/Threaded | Seated | Place\* | Sub-Total | | Small Gear | 3 | 2 | 1 |  | | Medium Gear | 3 | 2 | 1 |  | | Large Gear | 3 | 2 | 1 |  | | Rod 4 mm | 3 | 2 | 1 |  | | Rod 8 mm | 3 | 2 | 1 |  | | Rod 12 mm | 3 | 2 | 1 |  | | Rod 16 mm | 3 | 2 | 1 |  | | Bar 4 mm x 4 mm x 300 mm | 3 | 2 | 1 |  | | Bar 8 mm x 7 mm x 300 mm | 3 | 2 | 1 |  | | Bar 12 mm x 8 mm x 300 mm | 3 | 2 | 1 |  | | Bar 16 mm x 10 mm x 300 mm | 3 | 2 | 1 |  | | BNC Connector | 3 | 2 | 1 |  | | Waterproof Connector | 3 | 2 | 1 |  | | DSUB Connector | 3 | 2 | 1 |  | | USB Connector | 3 | 2 | 1 |  | | RJ45 Connector | 3 | 2 | 1 |  | | M4 Nut | 3 | 2 | 1 |  | | M8 Nut | 3 | 2 | 1 |  | | M12 Nut | 3 | 2 | 1 |  | | M16 Nut | 3 | 2 | 1 |  | | Note: Max Score = 120 Total Score | | | |  |   \*The part is manipulated to the task board and at least sits on the task board  Example of start and end of an assembly trial with 100% completion:    Start End |
| Details of Setup | Describe your system design including robots and end-effector technologies used, perception type and how it is used to localize board, kit and components, use of CAD. Also describe all tools used with end-effectors. |
| Results to Submit | Submit scoresheets and a summary of results over 32 trials to include analysis of speed, completion, and reliability. Make notes in the summary of the incomplete/failed tasks and the reasons for the failure. Speed is measured as the completion time of a task board as:  Ttaskboard = Tfinish − Tstart.  Task board completion should be reported as the percentage of total points received for each task board for disassembly and assembly.  % Disassembled = Total Score/60 x 100  % Assembled = Total Score/120 x 100  For each set of 32 trials, compute the mean, standard deviation, and 95% confidence interval of the completion times, disassembly completion and assembly completion.  Reliability can also be captured as the probability of successfully completing a task or sub-task. The theoretical upper bound probability for successfully inserting a component (PS) is calculated given a confidence level (CL), the number of successes (m), and the number of independent trials (n). Given the binomial cumulative distribution function:    The PS is its minimum value to some precision while still satisfying the above inequality. |