UNDERACTUATED HAND MODELING BENCHMARK

Reference No / Version	B1-v1.0
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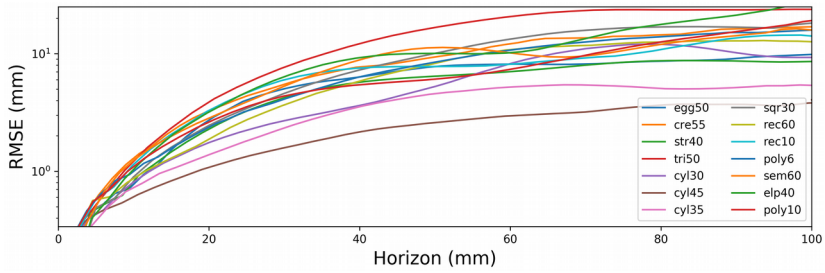
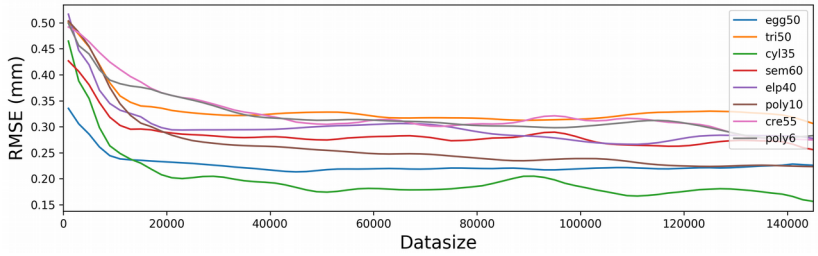
Adopted Protocol	Underactuated hand modeling protocol (P1-v1.0)
Scoring	If performed on simulation or on a new system: Record test paths, for each object, given 10 sequences of actions (given in the website): 1. Position an object in the grasp region. 2. Close fingers until they reach load of 100 (in Dynamixel units). 3. Stream sequence of actions in 10Hz to the actuators. 4. Record state of system in 10Hz. 5. Repeat 1-4 for all action sequences. If used on the provided (RUM) dataset, use prerecorded test paths. Scoring should output the following items for all test objects: <u>Figure 1:</u> 1. Sample a state *s* from the 10 recorded test paths. 2. Sample an horizon *h* (number of steps to predict). 3. Predict, using the evaluated model, the path from *s* with horizon *h*. 4. Compute Root-Mean-Square-Error (RMSE) between recorded and predicted paths, and store along with the horizon (converted to mm). 5. Repeat 1-4 for 1,000 times. 6. Plot the figure (example below) by averaging bins along the horizon axis.  <u>Figure 2:</u> 1. Initiate *n*=1000. 2. Train model with *n* data points. 3. Sample a state *s* from the 10 recorded test paths. 4. Predict, using the model, horizon of 10 steps from *s*. 5. Compute RMSE between predicted path to the ground truth, and store. 6. Repeat 3-5 for 100 times and average the error. 7. Repeat 1-5 while increasing *n* from 1,000 to the maximum available points with increments of 2,000 points. 8. Plot the figure (example below).

	 Prediction time: Scoring should also report the mean model computation time of one step prediction averaged over 1,000 trials. Closed-loop control: Using the model, apply a model-based closed loop controller to track the 10 test paths, with each object. Report RMSE, over all paths, between the reference path and the actual tracking path.
Details of Setup	Defined in the protocol.
Results to Submit	Two plots as described above, average computation time for one prediction, and RMSE for closed-loop tracking error.