BURG-Toolkit: Robot Grasping Experiments in Simulation and the Real World

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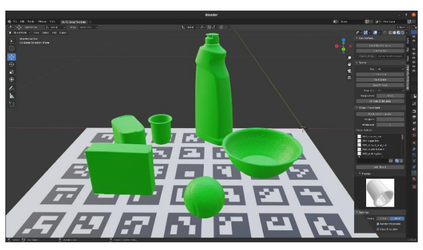
https://mrudorfer.github.io/burg-toolkit/

MOTIVATION

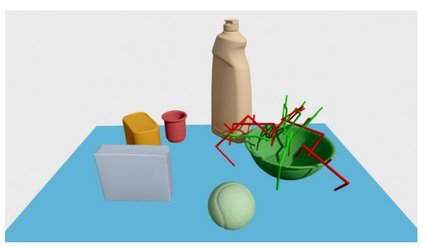
The BURG-Toolkit is a set of open-source tools for **B**enchmarking and **U**nderstanding **R**obotic **G**rasping.
Our tools allow researchers to:

- create physically plausible, virtual scenes for generating training data and grasping in simulation,
- recreate the scenes by arranging the objects accurately in the physical world for real robot experiments,
- share scenes with the community to foster comparability and reproducibility of experimental results.

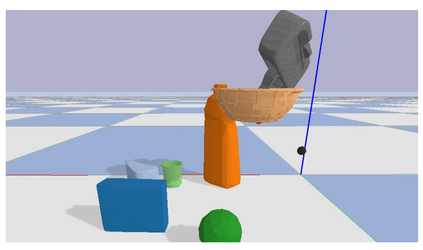
OVERVIEW



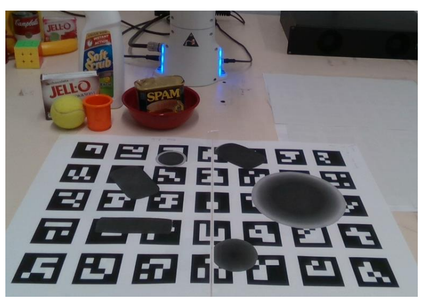
1: Scene creation in SetupTool



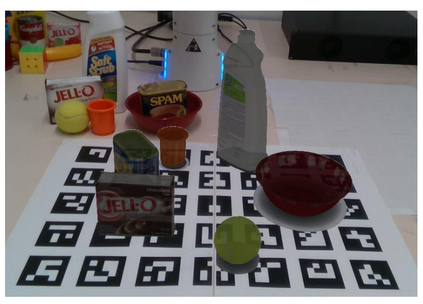
2: Sampling grasps



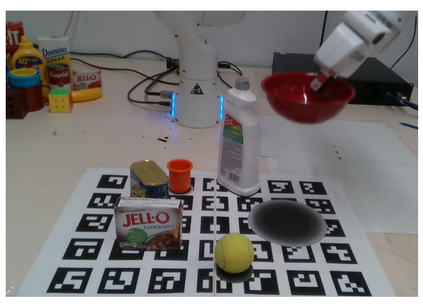
3: Grasp execution in simulation



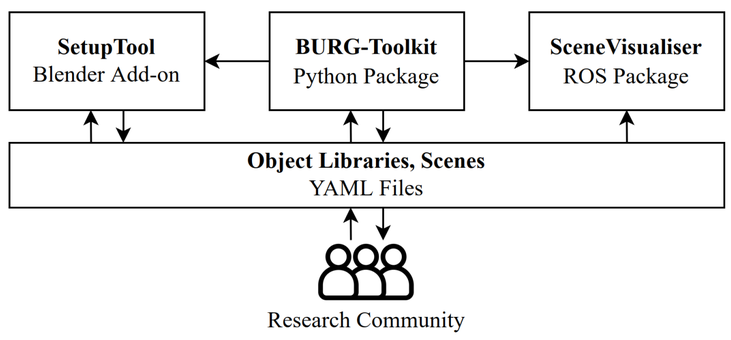
4: Printed placement indications



5: AR projections for placement

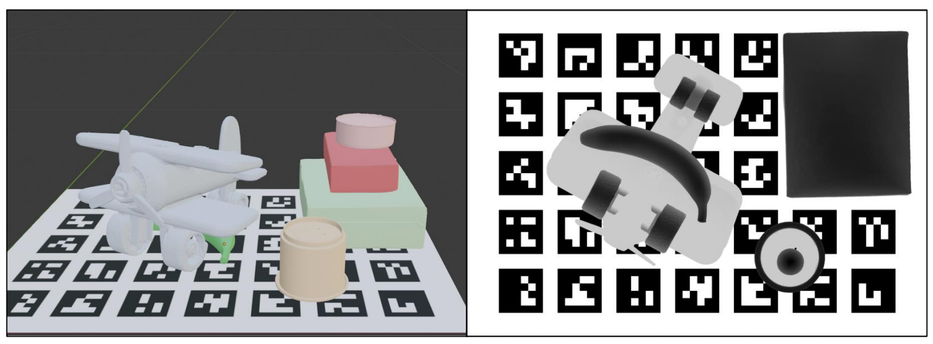


6: Real-world grasp execution

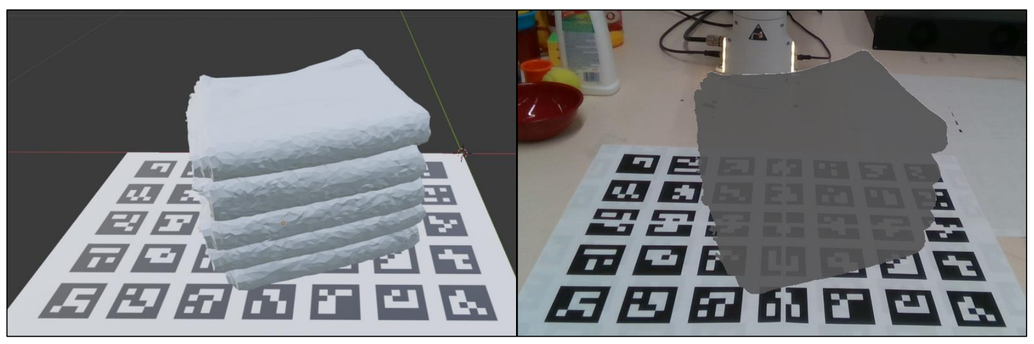


A Python package provides the core functionality directly or as backbone for the other components. The Blender-based SetupTool allows intuitive arrangement of objects in scenes, exploiting pre-computed stable resting poses. The SceneVisualiser recognises markers on the printout and projects the objects for accurate placement. Object libraries and scenes are stored in YAML files to facilitate sharing with the community.

CHALLENGING GRASPING SCENARIOS

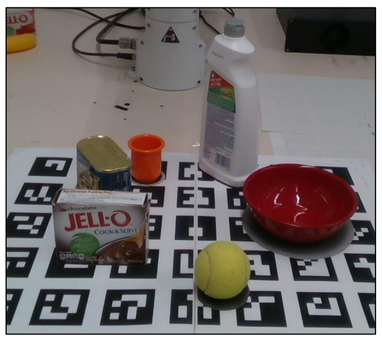


Printed placement indications and AR projections complement each other well for setting up complex scene configurations with hidden items (such as the banana and marble) or stacked objects like the boxes.



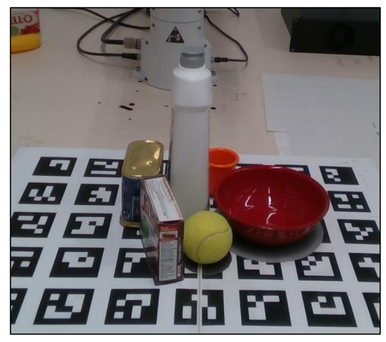
The SetupTool and SceneVisualiser can also be used to reliably arrange scenes with deformable objects in particular object configurations. However, the simulation-based grasp execution is currently only applicable to rigid objects.

ANALYSIS OF SIM-TO-REAL GAP IN GRASP EXECUTIONS



sim \ real	0	1	Σ
0	20	10	30
1	9	21	30
Σ	29	31	60

Precision: 70.00%
Recall: 67.74%



sim \ real	0	1	Σ
0	25	12	37
1	13	10	23
Σ	38	22	60

Precision: 43.48%
Recall: 45.45%

The toolkit can be used to analyse the sim-to-real gap in robot grasping, which we demonstrated with a proof-of-concept experiment. We created two different scenes where objects are wide apart or close together, respectively. Grasps were executed in simulation as well as with a real robot and we compared the outcomes. Results indicate that the simulator is less accurate for more compact scenes.

The work has been conducted in the scope of CHIST-ERA project BURG: Benchmarks for UndeRstanding Grasping, funded through EPSRC (EP/S032487/1) and FWF (I3967-N3).
It has been originally presented at the ICRA 2022 Workshop on Releasing Robots into the Wild: Simulations, Benchmarks, and Deployment.

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