Large-Scale Object Generation for Learning Robotic Manipulation Tasks

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INTRODUCTION

- Data-driven methods have proven to be successful when applied to problems in fields such as computer vision and natural language processing.
- We apply the data-driven method in training a dual-arm agent on the task of fitting two parts with a geometric relationship together (Figure 1.1).
- The dual-arm agent will be trained to perform the task in simulation with generated 3D objects (Figure 1.2).
- This project focuses on the programmatic generation of the 3D object model data to be trained and evaluated on.

RESEARCH QUESTION

How can we generate large amounts of 3D object model data with minimal human involvement that can be used to simulate contact-rich robotic manipulation tasks?

METHODS

- The 3D object models were generated using the **Blender Python API**[1].
  - Object models come in pairs: one with an extrusion (the "cap"), one with an intrusion (the "bottle").
  - Extrusions/intrusions range from one-symmetry shapes (arrow) to many-symmetry shapes (circle).
  - 8cm x 8cm x 8cm cube body, uniform tolerance of 4mm on extrusions
  - Additional parameters on the original models allow for more variation in the data set (Figure 2).
- Physical replicas of models were 3D-printed for use in the real-world task.

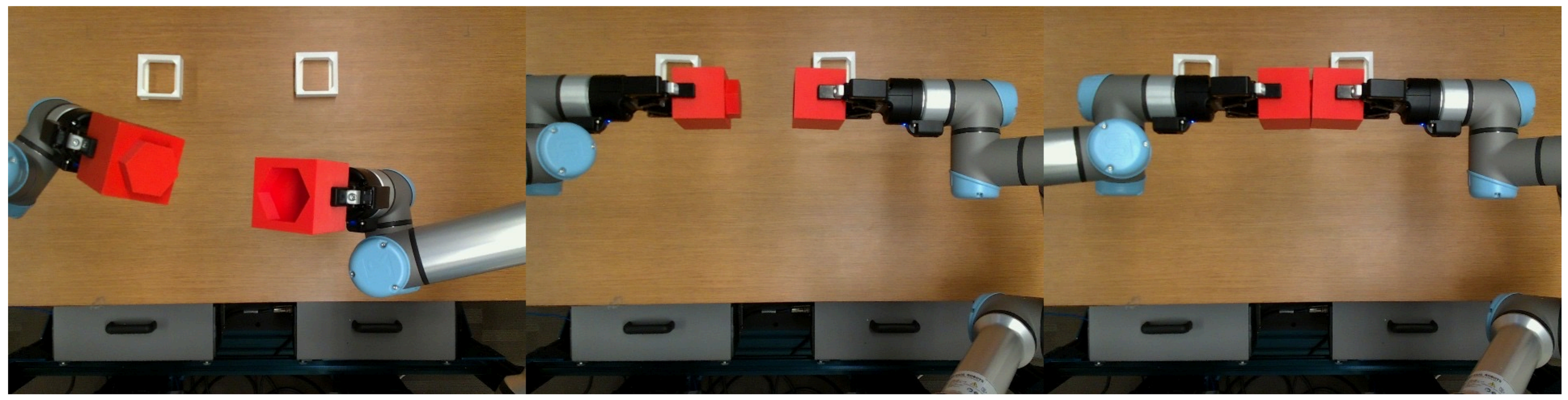

Figure 1.1: "Capping the bottle" in real life

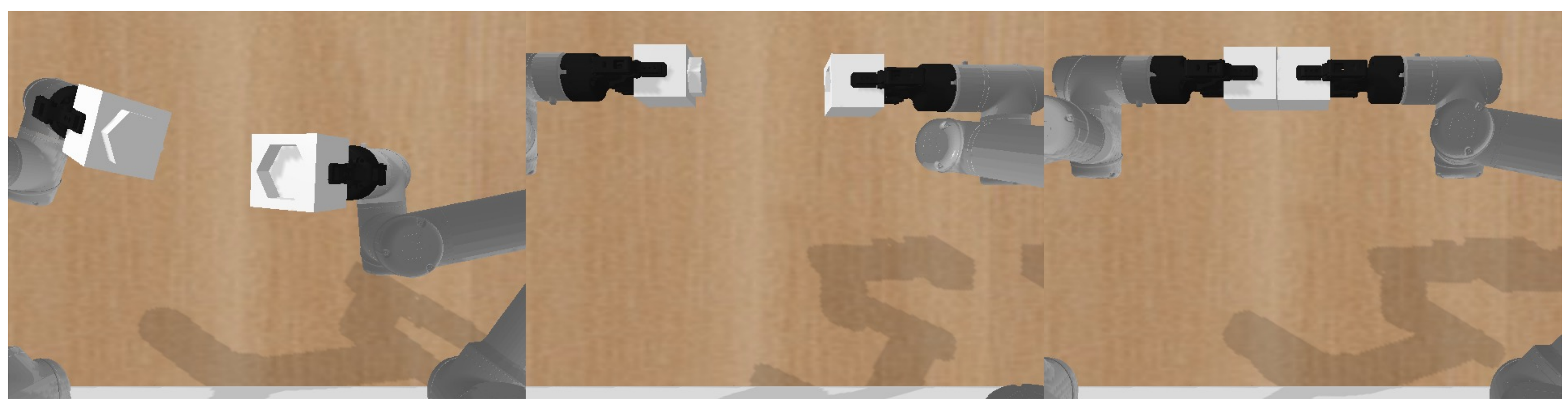

Figure 1.2: "Capping the bottle" in simulation

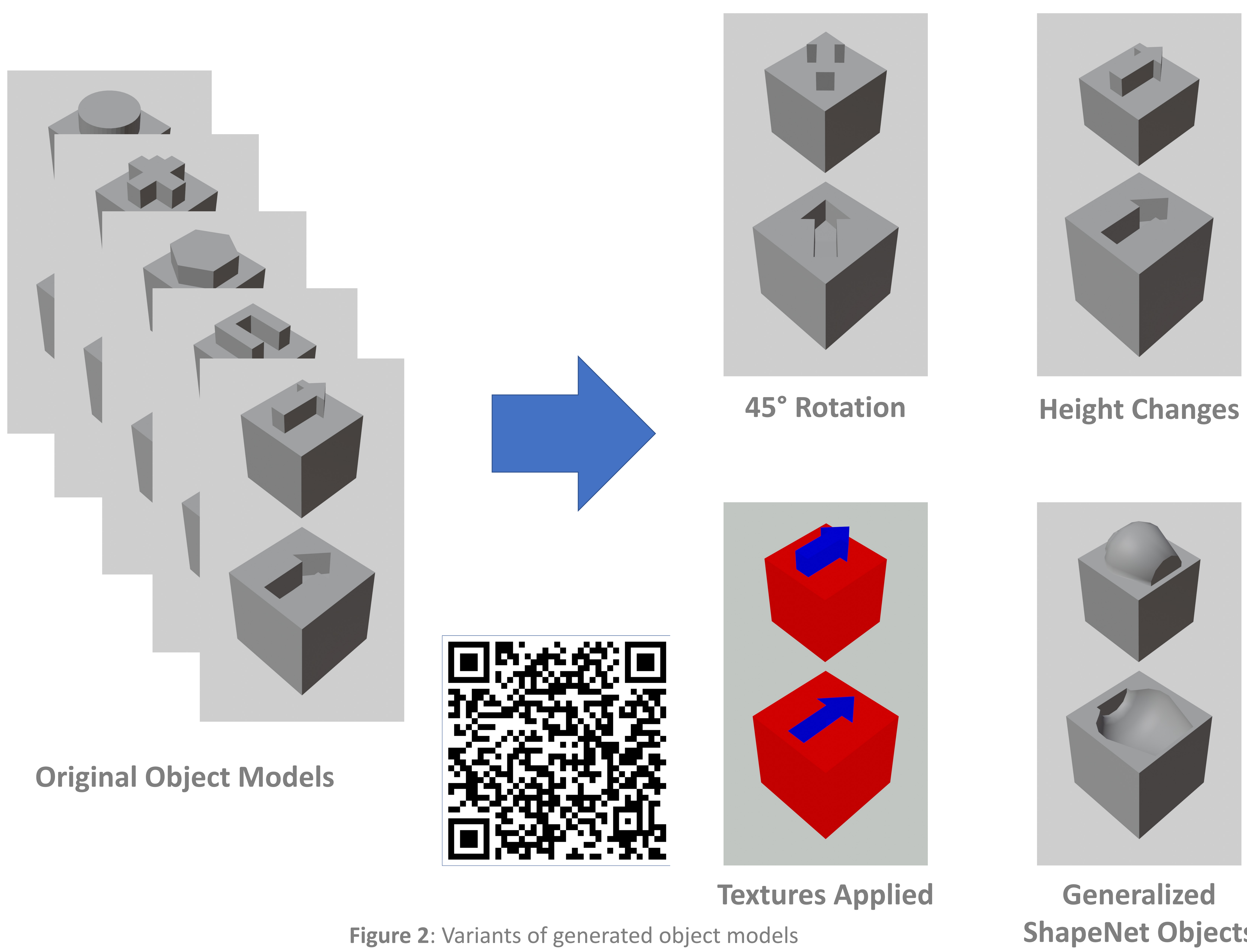

Figure 2: Variants of generated object models

RESULTS

- Creation of 18 base models --- 9 "caps" and 9 "bottles" over 9 intrusion/extrusion shapes.
- Programmatic method to generate large amounts of 3D model object data for the "capping the bottle" task.
- Several parameters to introduce high degree of diversity in generated data set to increase model's ability to generalize to unknown objects.

FUTURE WORK

- Generated base models and their variations are to be used in a simulated "capping the bottle" task.
- 3D-printed physical replicas to be used in real-world "capping the bottle" task to evaluate learning.
- **ShapeNet**[2] objects (Figure 2) to be used to evaluate generalization ability of model trained on original models.

ACKNOWLEDGEMENTS AND REFERENCES

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Figures 1.1 and 1.2 provided by Carl Winge and Chahyon Ku.

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