# An Object-Based, Hand-Independent Algorithm for Creating Teleoperation Mappings <sup>1</sup>Columbia University, New York USA

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# Motivation

- As human-robot collaboration becomes more prevalent, it is important that human and robotic agents can communicate effectively
- There exist a variety of teleoperation mappings which harvest the motions of the user's hand to provide intuitive, efficient, and safe control interfaces for users.
- However, the field is lacking in intuitive, novice-friendly ways to <u>create</u> these teleoperation mappings.





### Proposed Method: Teleoperation Subspace

#### **Key Research Questions:**

- Can a mapping created without hand specific intuition still enable intuitive teleoperation? **Methods:**
- We create an algorithm that generates teleoperation mappings between human and robot hands *without* requiring heuristics or intuition at a hand specific level
- We hypothesize that there is a subspace relevant to teleoperation which can be described by the objects for which it enables grasping (Fig. 1)
- A hand grasping an object in the set lies at the same point in the subspace as the object itself
- We create teleoperation mappings by fitting a subspace to

Figure 1 - Illustration of a subspace defined by the objects for which it enables grasping



- hands grasping this object set (Fig. 2)
- We create the set of grasps using a grasp planner, and fit the subspace using RANSAC
- **Advantages:**
- Creating mappings with an algorithm, rather than intuition, eliminates the work needed to compensate for differences between hands, which is often a significant barrier for novices.

# Experiments

- Using our algorithm, we created mappings for the human hand and the Schunk SDH hand (Fig. 3)
- An expert user performed pick and place tasks using the generated teleoperation mappings (Fig. 4)
- Successful pick and places show that the subspace defined by the object set is relevant to teleoperation (Fig. 5).

Figure 2 - Objects in the object set. Name indicates the the shape primitive, the width in mms, then the length.



Figure 3 - Teleoperation mapping generated by the algorithm for the human and Schunk SDH hands



Figure 4 - Illustration of pick and place tasks by an expert user

place objects