# Shallow-Depth Insertion:
## Peg in Shallow Hole through Robotic In-Hand Manipulation


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## Motivation

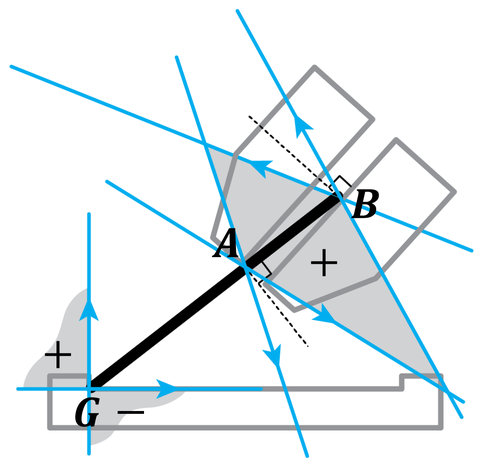
**Conventional Peg-in-Hole** VS **Shallow-Depth Insertion**

**Objective:** Assembly of thin peg-like object into hole with shallow depth that necessitates ***dexterous in-hand manipulation***.

**Application:**

## Grasp Analysis

### Moment Labeling




**Contact A & B:**
Friction cones represented by two unit wrenches per contact.

**Contact G:**
Two unit wrenches as two contact normal.

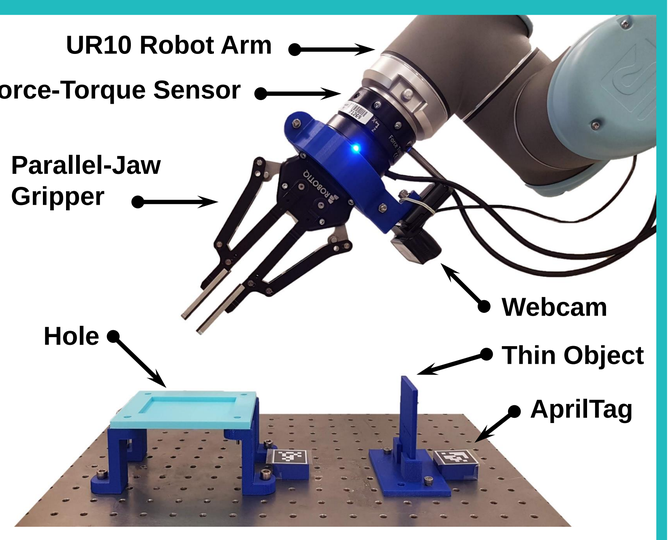
The object can be in ***force-closure*** with all the contact wrenches.

**Grasp stability guaranteed.**

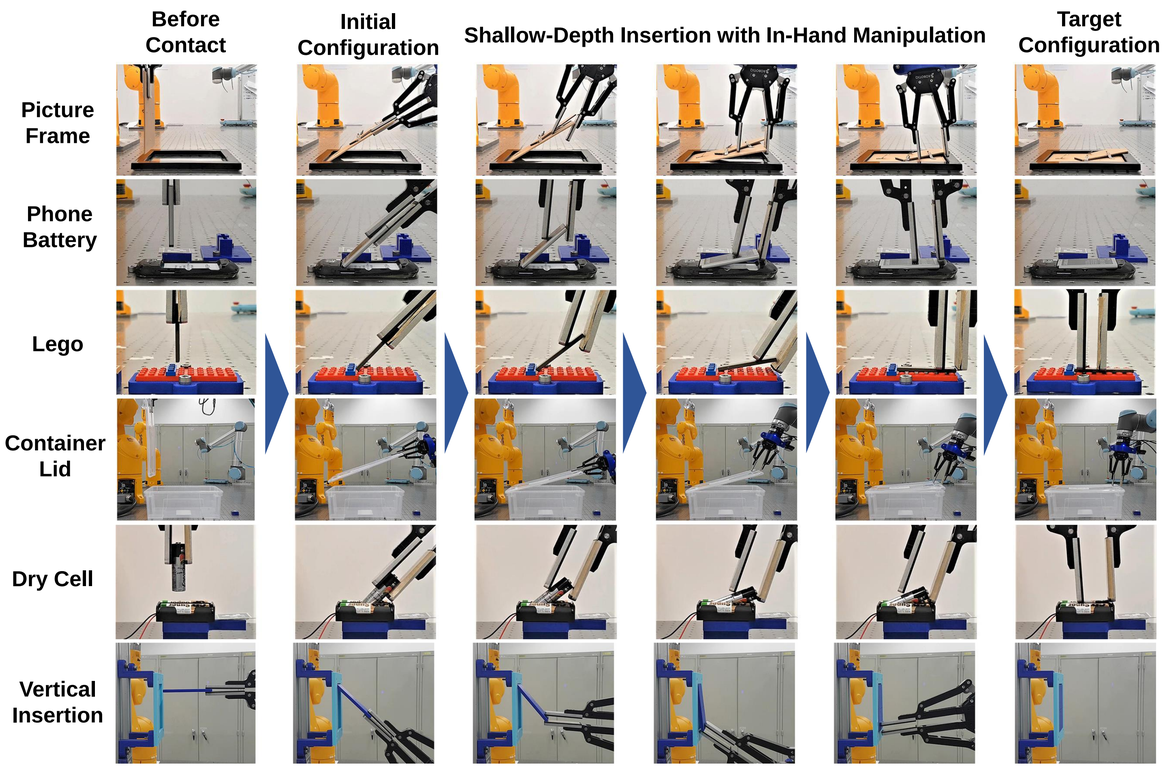
## Implementation

### Experiment Setting

ⓘ Scan the QR code to watch a video.

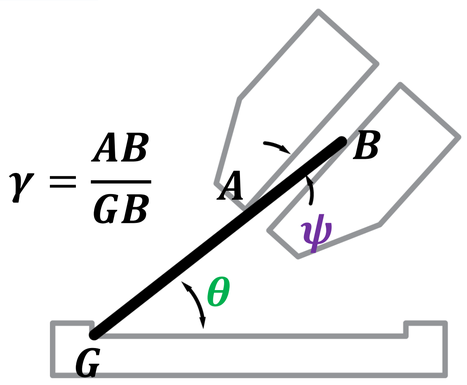



### Scenarios



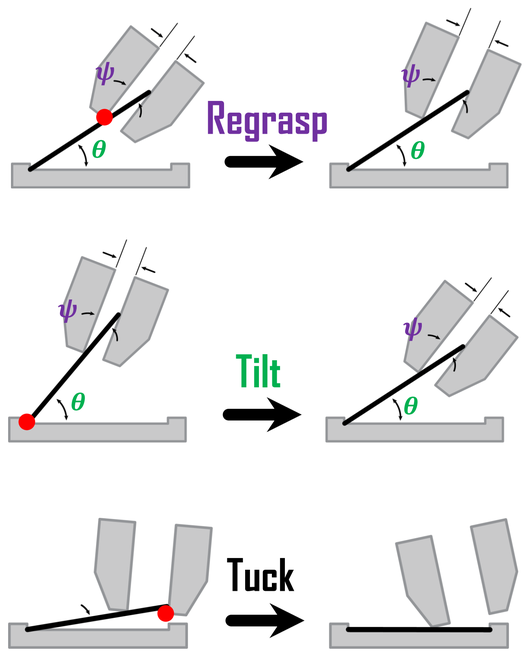

## Our Approach

### Model

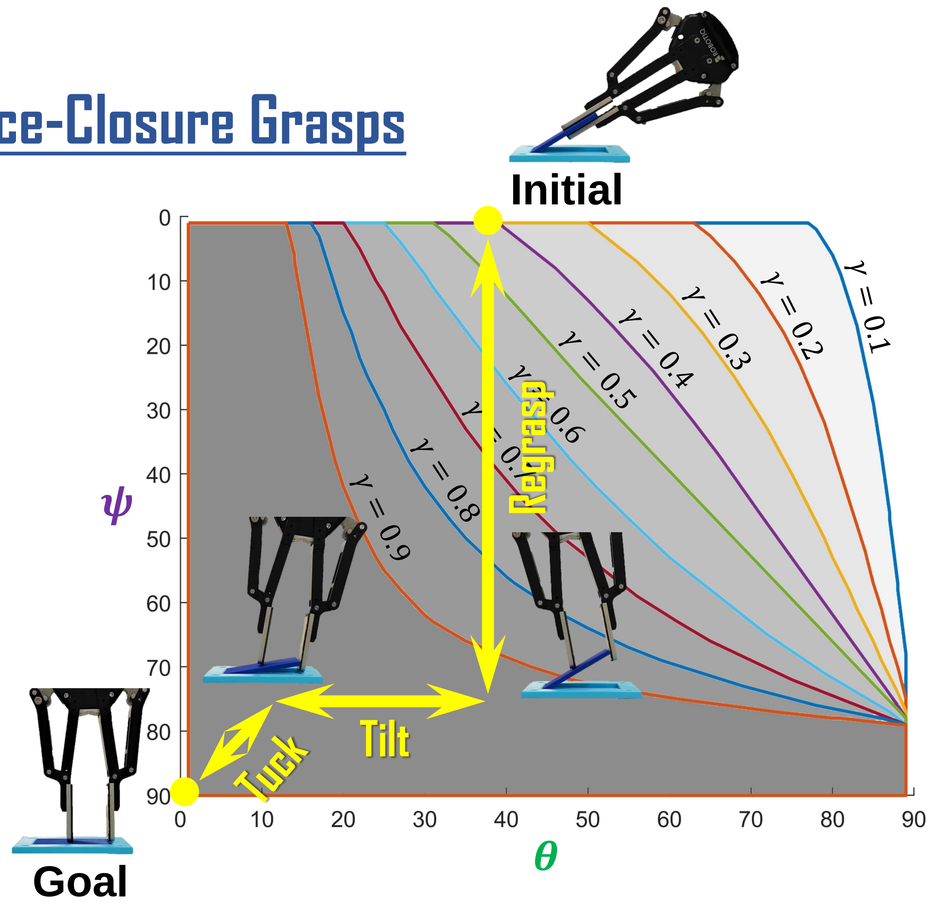



Configuration space modeled by three parameters ($\psi$, $\theta$, $\gamma$) navigated by three manipulation primitives: regrasp, tilt, and tuck.

### Manipulation Primitives




### Force-Closure Grasps




## Result

| | |
|---|---|
| **Success Rate:** | 96% (154 successful attempts out of 160 trials) |
| **Average Regrasp Time:** | 18.5 s |
| **Fastest Regrasp Time:** | 2.5 s |