Learning Dexterous In-Hand Manipulation


Setup & Task

Simulation Environment

Real-World Environment

Transfer

Deployment

System Overview

Goal

Train entirely in simulation and achieve zero-shot transfer to real robot hand.

Key Elements

1. Domain Randomization

Physics Randomizations

- Object Dimensions
- Object And Robot Link Masses
- Surface Friction
- Robot Joint Damping
- Backlash

Appearance Randomizations

- Object Tracking
- Policy

Quantitative Results

<table>
<thead>
<tr>
<th>Randomizations</th>
<th>Object Tracking</th>
<th>Policy</th>
<th>Number of Successes*</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>Motion Tracking</td>
<td>LSTM</td>
<td>0 11 19 6</td>
</tr>
<tr>
<td>All</td>
<td>Motion Tracking</td>
<td>FF</td>
<td>3.5 4.7 6.1 15</td>
</tr>
<tr>
<td>All</td>
<td>Motion Tracking</td>
<td>LSTM</td>
<td>15 10.6 17.1 50</td>
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<tr>
<td>All</td>
<td>Ultrasound</td>
<td>LSTM</td>
<td>11.5 92.2 14.3 4.6</td>
</tr>
</tbody>
</table>

*Measured across 10 trials. Each trial ends when the block is dropped or if 50 successes are achieved.

Qualitative Results

Tip Pinch Grasp  
Palmar Pinch Grasp  
Tripod Grasp  
Quadpod Grasp  
5-finger Precision Grasp  
Power Grasp

Classified according to "The GRASP Taxonomy of Human Grasp Types", Feix et al., 2016

Learn More

https://blog.openai.com/learning-dexterity/  
https://youtu.be/lwSbzNHGf0M