

# Post-Processing of Manipulation Trajectories

## Internship Report

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Sarah Braun

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Technische Universität München



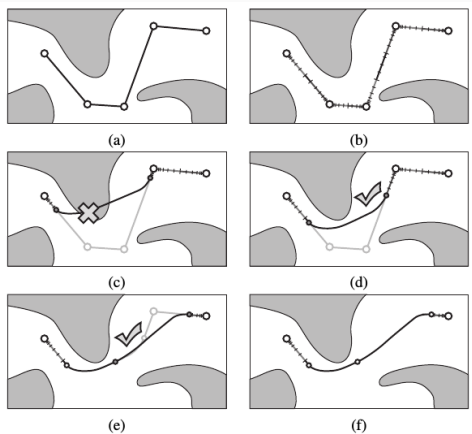
*TUM Uhrenturm*

# Evaluation of Various Post-Processing Strategies

1. Hauser's shortcutting idea
2. Smooth object interaction
3. Sampling of new transitions
4. Sampling of new grasps and placements

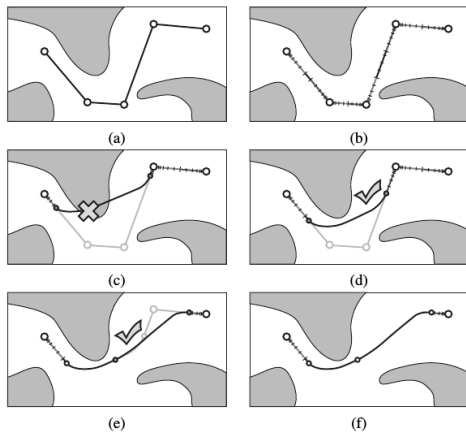
# Hauser's Shortcutting Idea

- ▶ sample two points
- ▶ compute shortcut
- ▶ check collisions



# Hauser's Shortcutting Idea

- ▶ sample two points
- ▶ compute shortcut **How?**
- ▶ check collisions



# Synchronization of Axes

## Basic Idea

- ▶ find "bottleneck" axis
- ▶ synchronize all axes to bottleneck time

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- ▶ find "bottleneck" axis
- ▶ synchronize all axes to bottleneck time

## Problem

- ▶ synchronization to arbitrary subsequent point in time not always possible
- ▶ each axis has inoperative time intervals in which axis cannot be synchronized

# Synchronization of Axes

## Basic Idea

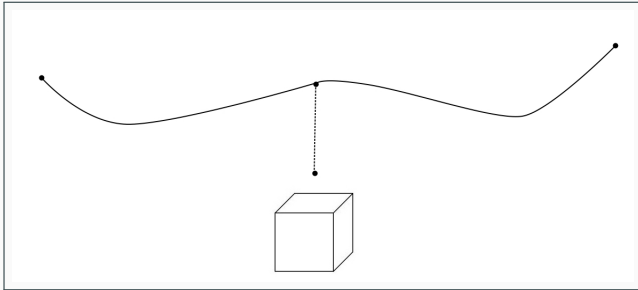
- ▶ find "bottleneck" axis
- ▶ synchronize all axes to bottleneck time

## Reflexxes

- ▶ find "bottleneck axis" and inoperative time intervals
- ▶ synchronize all axes to earliest possible point in time

# Smooth Interaction

- ▶ "interaction" = approaching the object to be gripped

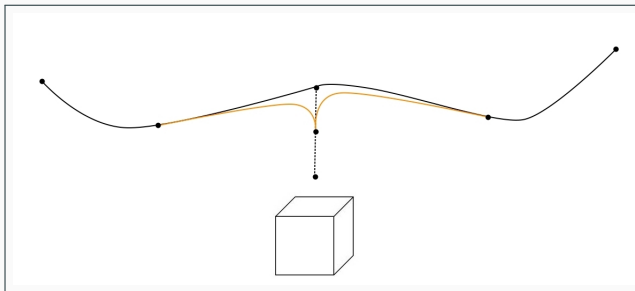


- ▶ stopping takes a lot of time



# Smooth Interaction

- ▶ "interaction" = approaching the object to be gripped



- ▶ better: slide smoothly into linear movement
- ▶ use Reflexxes for computation of orange motion

# Sampling of New Transitions - Basic Idea

- ▶ Recall: Manipulation Planner  
PHILIPP'S IMAGE
- ▶ Idea: Sample new transitions and re-plan trajectories in adjacent modes

# Sampling of New Transitions - More Details

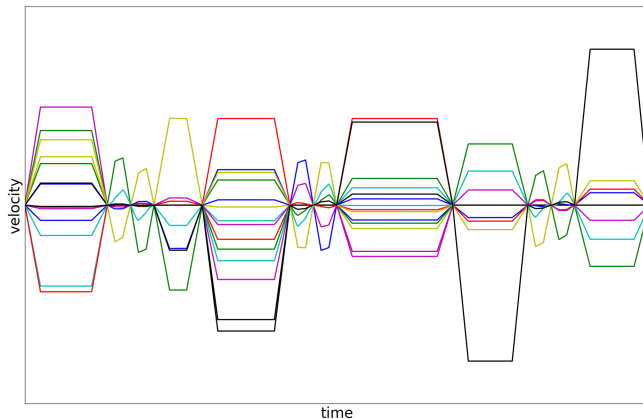
- ▶ new transition is ...
  - ▶ ... either new inverse kinematic include picture
  - ▶ ... or arbitrary valid configuration include picture
- ▶ Replan using Reflexxes:  
include picture similar to Philipp's

# Sampling of New Grasps and Placements

- ▶ Recall: Within-contact roadmaps for a couple of *fixed* grasps and placements
- ▶ Idea: Also sample new grasps and replan
- ▶ Difficulties: new grasp changes planning scene for all subsequent modes, expensive updates
- ▶ Evtl auch hier Grafik

# Evaluation

Simple pick-and-place task **without** Post-Processing

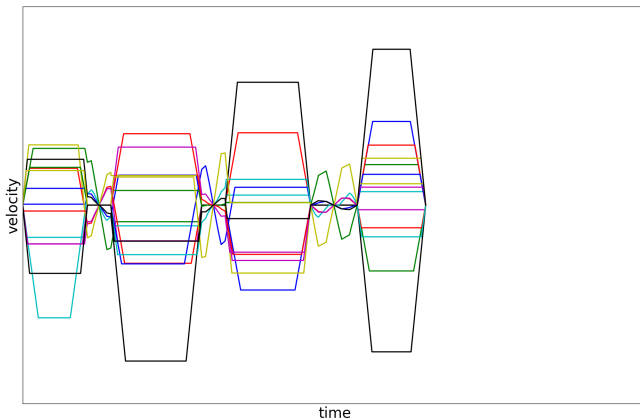


# Evaluation

Simple pick-and-place task **without** Post-Processing

# Evaluation

Simple pick-and-place task **after** Post-Processing



# Evaluation

Simple pick-and-place task **after** Post-Processing



# Comparison of the Post-Processing Steps