Closed-loop 6D Robotic Grasping of Unseen Objects

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Why is Robotic Grasping Challenging?

Example: Picking up a mug

Environment Diversity

Task Diversity
The Perception, Planning and Control Loop

Perception → Planning → Control → Learning → Sensing

Tasks

World

Action
Task: 6D Robotic Grasping

Perception → Planning → Control

World

Sensing → Learning → Action
Model-based 6D Robotic Grasping

**Perception**
- 6D Object Pose Estimation

**Planning**
- Manipulation trajectory planning

**Control**
- Manipulation trajectory following

- Require 3D models of objects
- Open-loop
6D Grasping of Unseen Objects

Perception

Unseen object instance segmentation

Planning

Grasp planning from point clouds

Control

Manipulation trajectory following

Figure Credit: Murali-Mousavian-Eppner-Paxton-Fox, ICRA’20

- Open-loop
Learning Closed-Loop Control Policies for 6D Grasping

Segmentation

Point cloud

Image

Perception

State $S_t$

Action $\alpha_t$

Policy

Deep Neural Network

Closed-Loop

Relative 3D Translation and 3D Rotation

No planning?

Control

Learning from Demonstration with the OMG-Planner

50,000 trajectories
1,500 3D shapes

Our Learned Policy in the Real World

Closed-Loop Human-Robot Handover

Closed-Loop Human-Robot Handover

Closed-Loop 6D Grasping in Cluttered Scenes

Intelligent Robotics and Vison Lab

Robot Skills Generalizable and Shareable

Perception
Planning
Control
Learning

Deploy ↓ Improve ↑

Robotic Systems