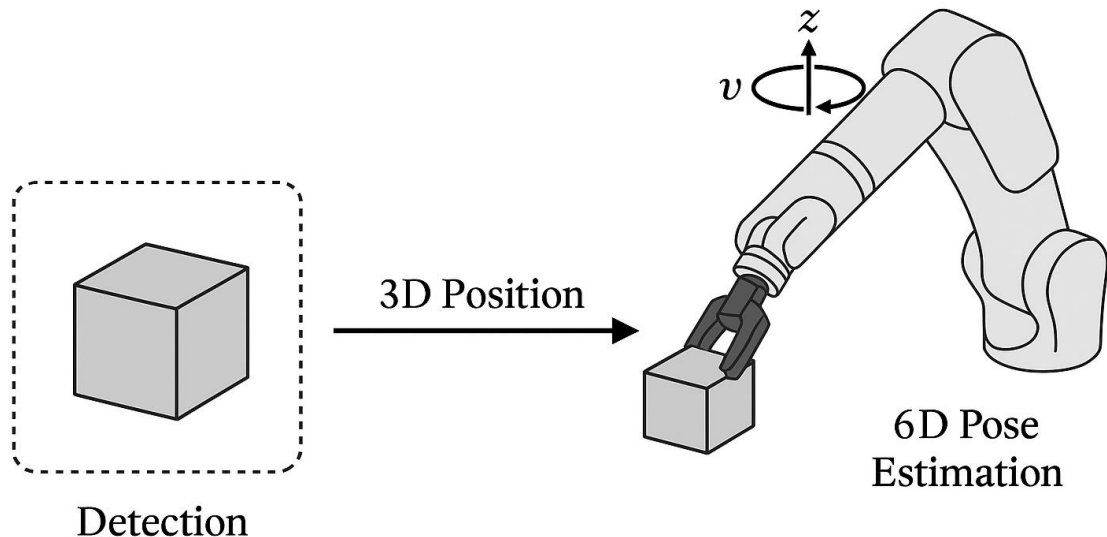


Object Detection and Grip Pose Estimation for Robotic Manipulation

CeTIBAR



Background:

Modern robotic systems operating in unstructured environments, such as the CeTIBAR robotic kitchen, require reliable perception to handle a wide variety of everyday objects. Object detection and grip pose estimation are key components that enable robots to locate and grasp items such as cups, utensils, or ingredients with precision and adaptability.

This project investigates how visual perception systems can be designed and optimized for robotic manipulation tasks in complex domestic settings.

Students will explore state-of-the-art methods for object detection (e.g., YOLO, DETR, Mask R-CNN) and grasp pose estimation (e.g., GraspNet, Dex-Net, keypoint-based 6D pose estimation).

The goal is to understand how perception pipelines can support safe, flexible, and human-aware manipulation within the CeTIBAR research environment.

Tasks:

- Gain an understanding of the fundamentals of object detection and pose estimation for robotic grasping.
- Study existing approaches for 2D and 3D object detection and their applicability in domestic or cluttered environments.
- Explore publicly available datasets (e.g., YCB, GraspNet, KIT Object Models) and identify those suitable for kitchen-related tasks.

- Implement or adapt baseline detection and pose estimation models using PyTorch or TensorFlow.
- Evaluate models in simulation or on recorded RGB-D data from the CeTIBAR kitchen setup.
- Analyze trade-offs between detection accuracy, pose estimation precision, and inference speed.
- Visualize qualitative results (e.g., grasp heatmaps, 3D bounding boxes) and summarize quantitative findings.
- Discuss the limitations of current methods and outline potential extensions for integration into real robot systems (UR / Panda in CeTIBAR).
- Prepare a short written report and presentation summarizing insights and recommendations for future perception modules in the CeTIBAR research environment.

Keywords:

Object detection, gripper pose estimation, 6D pose estimation, grasp planning, deep learning, collaborative robots, human–robot collaboration, manipulation in unstructured environments

Language:

German / English

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