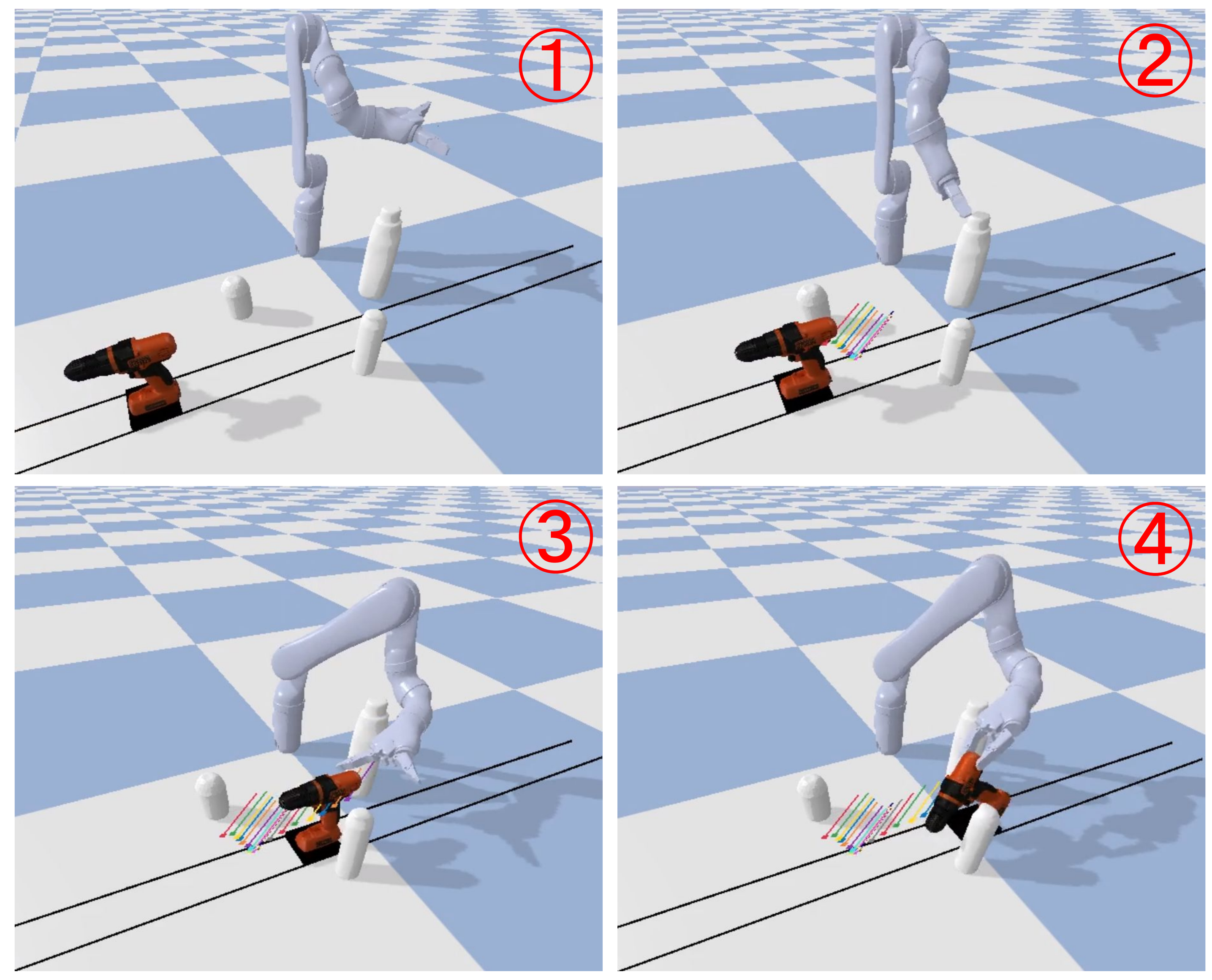
Online Robotic Grasping for Moving Objects

Iretiayo Akinola, Jingxi Xu and Peter Allen,
Columbia University

Overview: Previous works have addressed dynamic grasping by introducing a number of assumptions such as prior knowledge of the object motion, waiting for the object to come to rest before grasping, limiting the grasping directions to a single direction (e.g. only top-down grasps).

In this work, we relax some of these assumptions and tackle the problem of robotic grasping for moving objects with no prior knowledge of the object's motion profile ahead of time and no restrictions on the possible grasping directions of the object.



The robot picks the moving target object (drill) while avoiding the surrounding obstacles.

Proposed Method: There are three key components to grasping dynamic objects; object motion prediction, online grasping and arm trajectory generation.

1. Object Motion Prediction
   a. Kalman Filter to filter and model motion state variables: position, velocity and acceleration
   b. DOPE: deep learning based method for instantaneous pose detection
2. Real-time Grasping
   a. Reachability-Aware grasping to generate reachable and stable grasps for the robots
   b. Real-time grasp updates by seeding grasp optimization with previous grasp solution
3. Arm Trajectory Generation
   a. Hybrid planner: combines cartesian control with trajectory optimization STOMP
   b. Seed trajectory optimizer with solution from previous time step

Conveyor Belt Experiment: In simulation, we vary distance to robot and speed of moving object in the presence of static obstacles. The experiment is repeated for eight different YCB objects.

Eight YCB objects used for conveyor belt experiment

Preliminary Results:

Slow speed:

- Online grasping with no object motion prediction gives 16% improvement over offline grasping
- Adding Kalman filter does not further improve performance

Medium speed

- High failure rate without Kalman Filter
- Motion prediction using KF improves success rate for both grasping algorithms

Fast speed

- Challenging for all methods
- Failure during approach and lift

Future Work:

- Smooth approach and lift
- Variable horizon length for object pose prediction
- Smooth non-linear motion
- Human-robot hand over

CRL

COLUMBIA | ENGINEERING
The Fu Foundation School of Engineering and Applied Science