

Motion Planning To Smoothly Intercept Moving Objects

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The Problem

- Kinematic planning techniques have been shown to be very effective in scenarios with static objects.
- However, these approaches fail when interacting with **dynamic environments with moving objects**.
- Among the key challenges faced in picking up moving objects are that planning needs to:
 1. Account for whether the solution will intercept the object at an appropriate time
 2. Obey the constraint that we typically don't want a large decelerations, in order to avoid breakages and spillages.

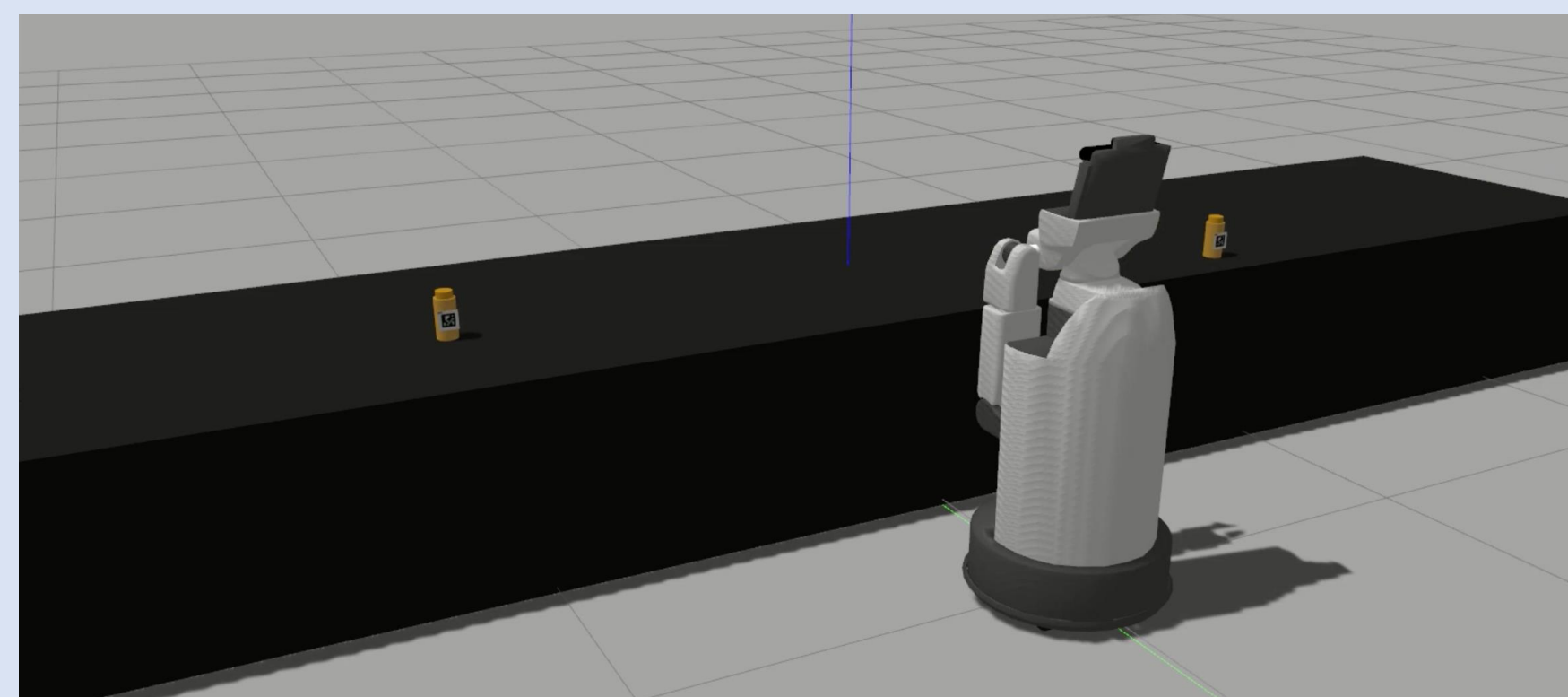


Fig 1. Toyota Human Support Robot in simulation environment with AR marked bottles on a conveyor belt

Our Approach

- We build on the search-based kinodynamic motion planning algorithm presented by Menon et al ¹ which generates a time-parameterised trajectory for whole-body motion in order to intercept an object at the earliest feasible point in it's trajectory.
- Previous research focussed only on planning in two spatial dimensions – **we extend planning to 3D**, greatly increasing the capabilities of the robot.
- **We propose a fast, on-the-fly heuristic** to counter the high dimensionality of the problem.

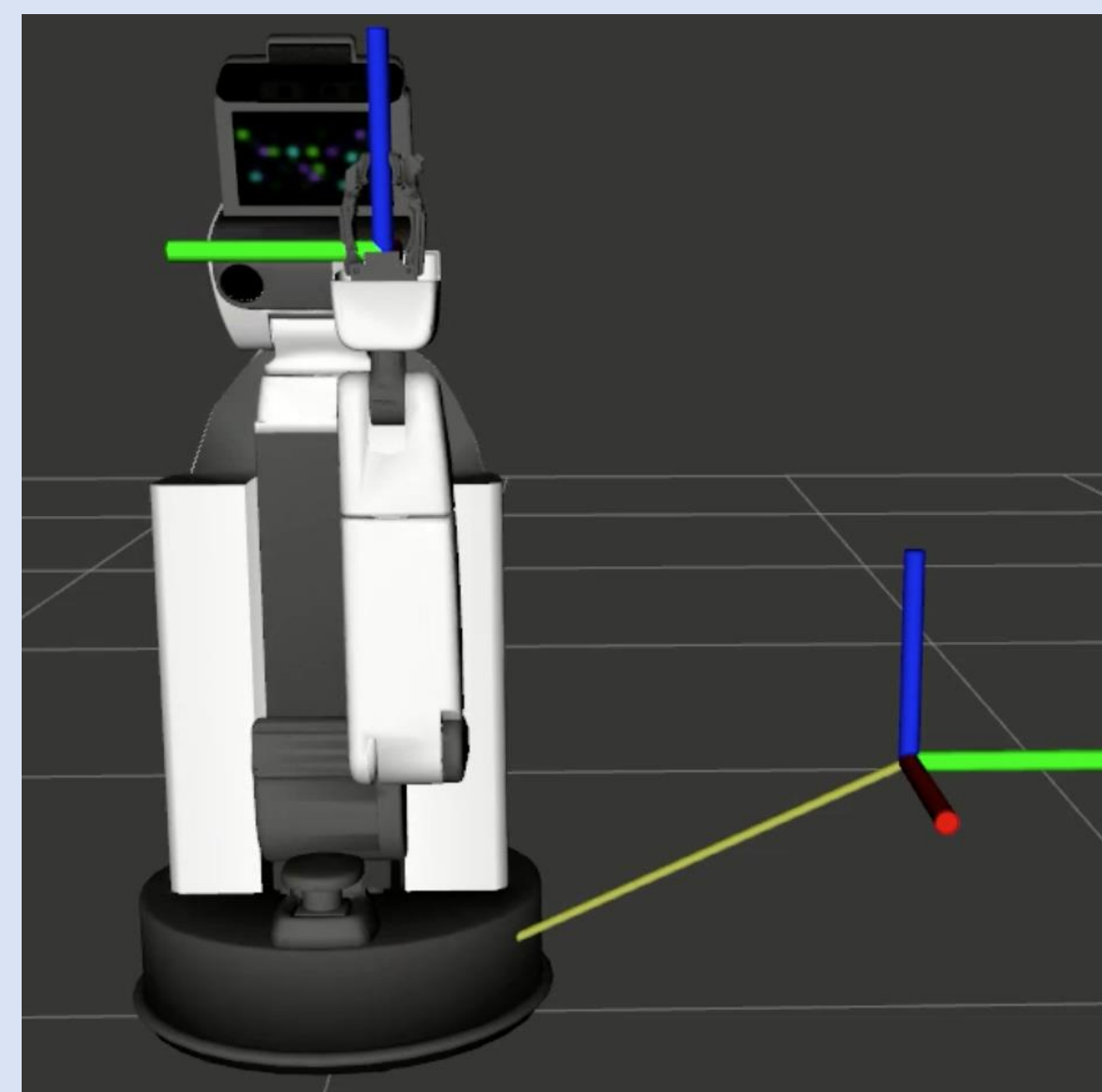


Fig 2. The robot was given a 3D cartesian goal for the hand link to intercept as illustrated.

Results

- Demonstrated the use of search-based motion planning (ARA*) to generate an accurate, time-optimal trajectory for a robot manipulator in simulation.
- Planner incorporates collision avoidance, generates a smooth trajectory and operates effectively in 3D Cartesian space.
- Preliminary results show the success of the planner and we now intend to focus on reducing the planning time and implement this in a dynamic environment as part of a full manipulation pipeline.

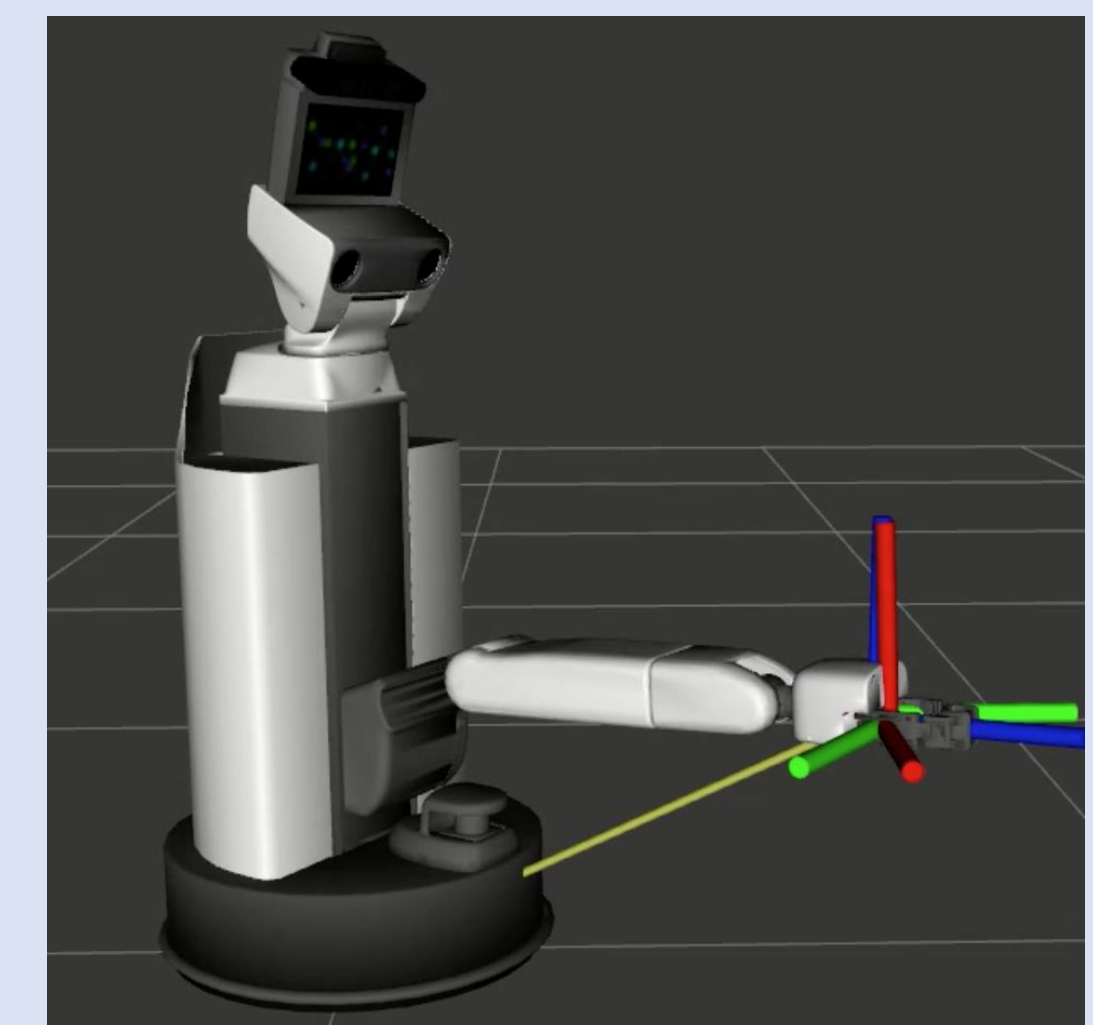


Fig 3. The motion planner successfully generated smooth trajectories to intercept the goal.

References

- [1] A. Menon, B. Cohen and M. Likhachev, Motion planning for smooth pickup of moving objects, IEEE International Conference on Robotics and Automation (ICRA), 2014.