Whole-Body Motion Planning for Manipulation of Articulated Objects

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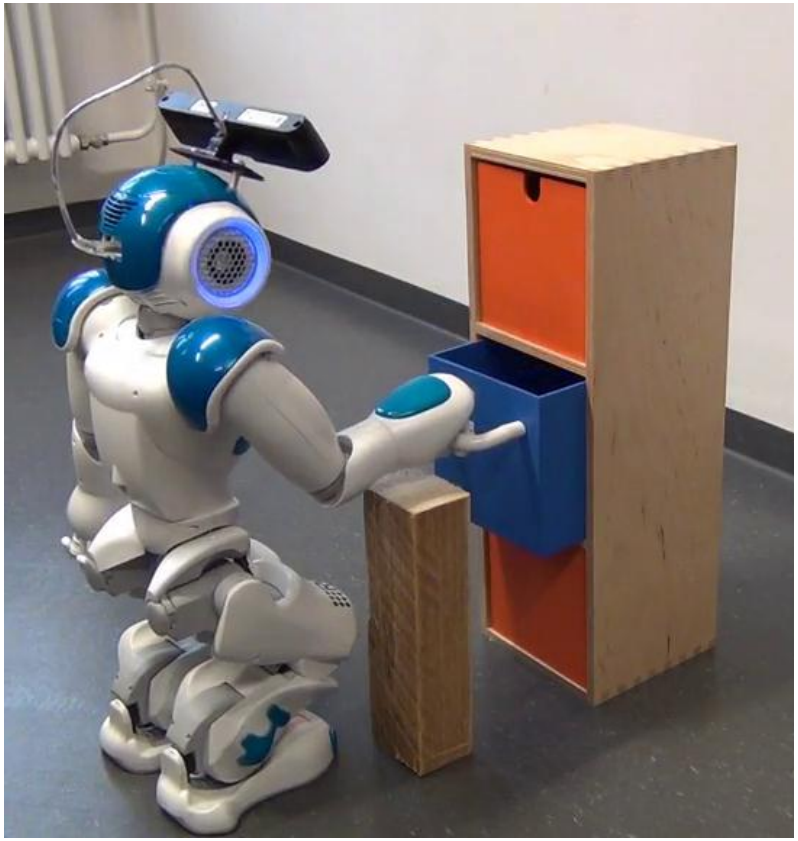
Motivation and Challenges

- Find a path through the high-dimensional configuration space

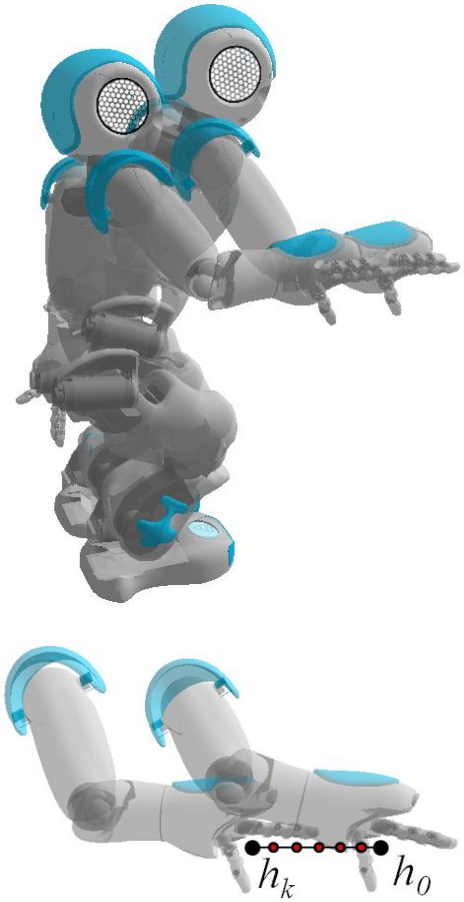


Constraints:

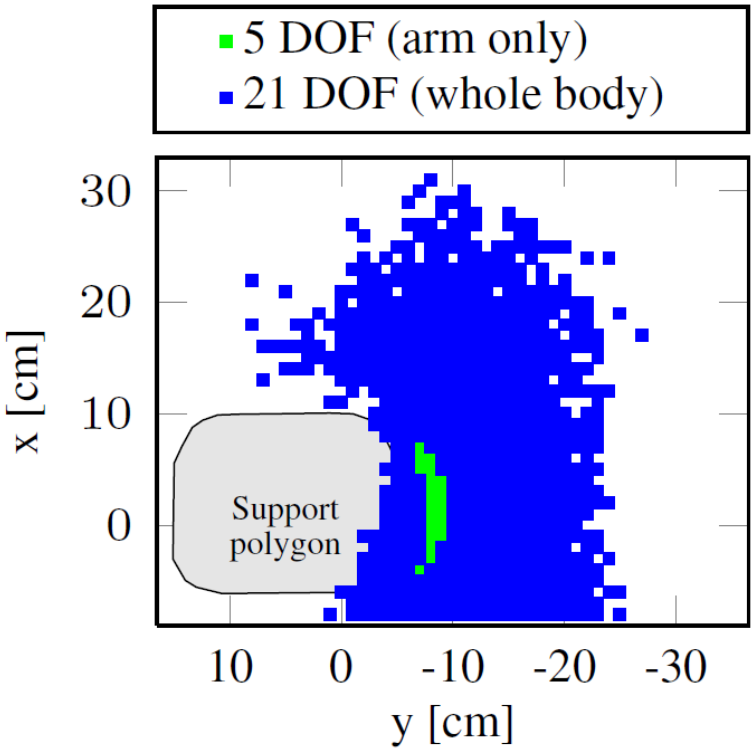
- Joint limits
- Avoid Collisions
- Maintain Stability
- Maintain Grasp
- Articulate Object

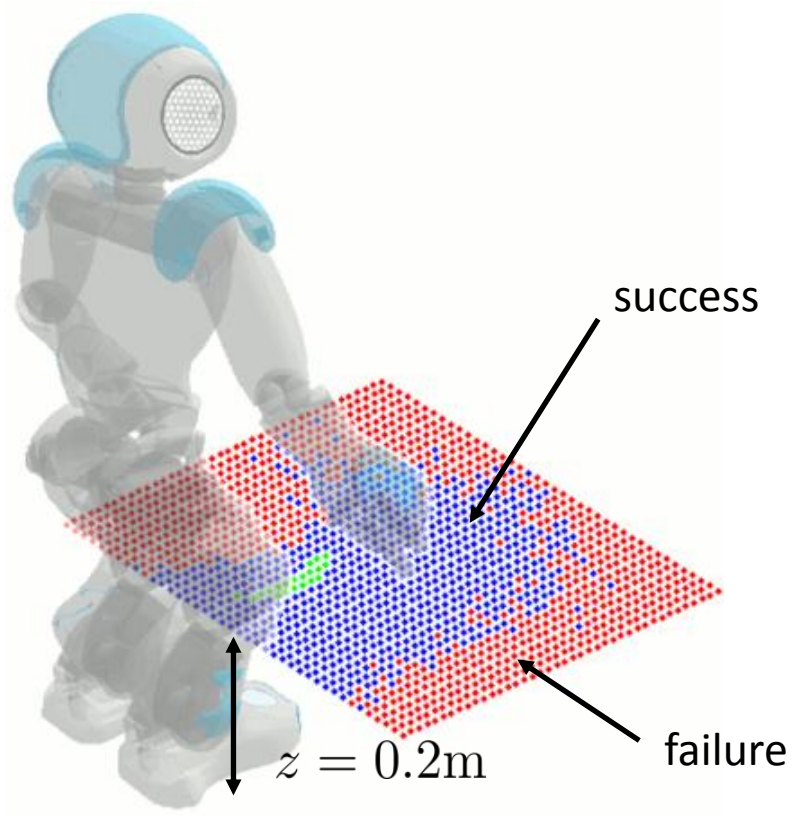
Our Approach

- Whole-body motion planner for statically stable, collision-free motions
- Manipulation of articulated objects
- RRT-Connect expansion guided by database of statically stable double support configurations
- Combination of sampling and IK for goal configuration generation
- Implemented using *MoveIt!* and *ROS*



Result: Extended Reachability





Results: Plan Execution

Opening a drawer with constrained end-effector trajectory and static stability

Opening a door with constrained end-effector trajectory and static stability

Opening a drawer with constrained end-effector trajectory, static stability and collision avoidance

Reaching into a cabinet with collision avoidance and static stability

Experiments – Evaluation

Scenario	Motion Plan	Search time [sec]	Number of Nodes	Gen. Goal Pose [sec]	Runs	Success Rate [%]
Drawer	Reach	0.08 ± 0.04	32.81 ± 8.41	5.42 ± 5.17	100	89
	Manipulate	0.11 ± 0.07	30.36 ± 12.69	4.14 ± 3.94		
Door	Reach	0.09 ± 0.05	32.16 ± 9.43	8.59 ± 7.54	100	78
	Manipulate	0.15 ± 0.08	35.17 ± 14.51	2.63 ± 2.47		
Drawer with Collision Av.	Reach	7.71 ± 3.0	1067.93 ± 333.54	16.24 ± 12.64	50	86
	Manipulate	0.2 ± 0.19	32.16 ± 21.09	8.53 ± 7.21		

- Off-board planning on a standard desktop CPU (Intel Core2 Duo, 3 GHz single core)