Planning for Robotic Manipulation of Articulated Objects

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Problem Statement
We wish to develop a planning approach for the manipulation of articulated objects. We approach this problem by developing a planner that will be able to unfold a folding chair.

Terminology
configuration: the full combined state of the robot and object (excludes open/close state of grippers)

grasp stance: a set of connections between robot grippers and the object

grasp transition: a configuration that is valid in multiple grasp stances (such as where one gripper can be open or closed), such that the robot can move from one grasp stance to another by opening or closing a gripper in this configuration

Approach
We structure the problem by breaking it into a discrete planning problem through the set of grasp transitions. The discrete planner is allowed to step from one grasp transition to another if two conditions are satisfied: the transitions have a grasp stance in common, and a feasible trajectory exists (in continuous space) from one transition to the next through the common grasp stance.

Thus, a completed plan forms a path with grasp transitions as way-points, with a gripper state change at each way-point, and a continuous trajectory between way-points

Left: An initial configuration

Center: An example of a grasp stance with one gripper on the back and the other on the seat of the chair

Right: A potential goal configuration

Challenges
•Perception of chair pose: we will use a set of AR Tags attached to the chair in a known arrangement to simplify the perception of the chair.
•Grasp stance constrained continuous planning: for some motions the continuous planner will have to account for the constraints of the kinematics of the chair

Continuing Work
We are currently implementing this approach using the PR2 robot and a standard folding chair of known dimensions and properties. When complete we hope to extend the work by designing ways to handle less precisely specified objects.

http://robotics.usc.edu/~max/