Open Up! Towards the Use of Human Strategies to address Pose Uncertainty in Grasp Planning

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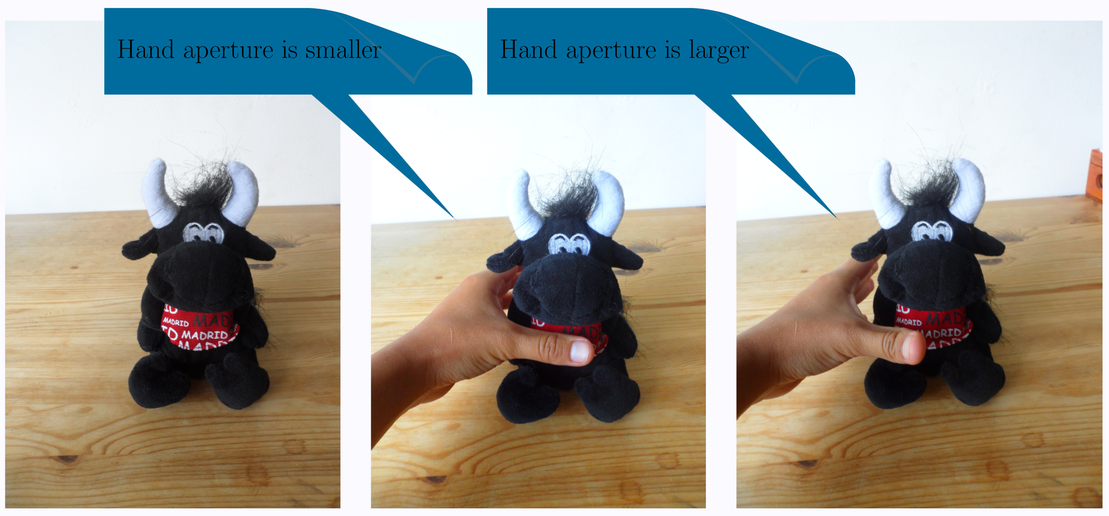
Abstract

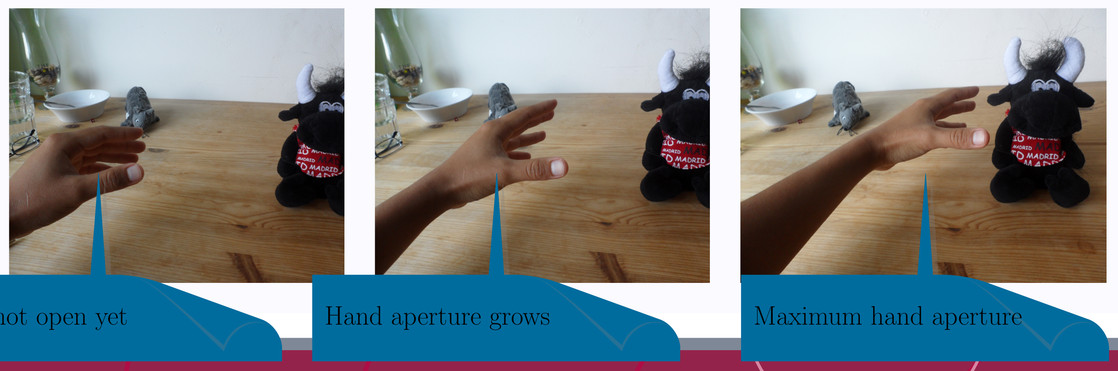
We present a manipulation planner for grasping tasks that takes into account the uncertainty of the object pose to guide the hand aperture during the reach movement. Most classical grasp planning approaches focus on calculating the optimal contact configuration of the fingers, assuming that the target object pose is known accurately, which in many cases is only an ideal situation. The strategy we present is based on studies showing that humans vary their finger configuration depending on how certain they are of the object pose.

How do WE deal with perceptual uncertainty?

- We change our hand aperture (distance between our thumb and the rest of opposite fingers), increasing it linearly with respect to the measured perceptual uncertainty (peripheral viewing variation)[2].



- Our maximum aperture is reached at approximately 80% of the distance traveled [2].



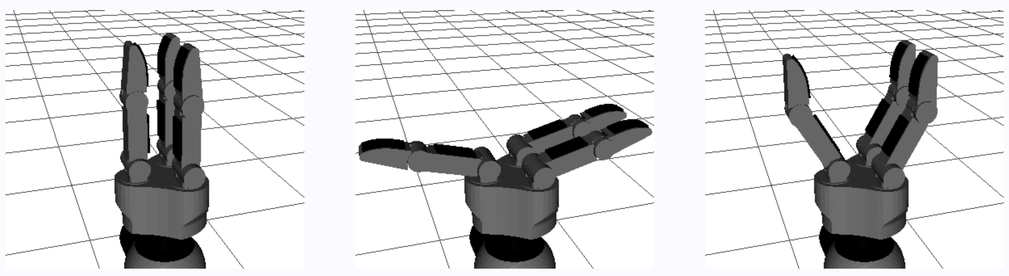
Approach

- Vary the aperture of the finger joints during the reaching movement as a function of the distance to the goal object to grasp.

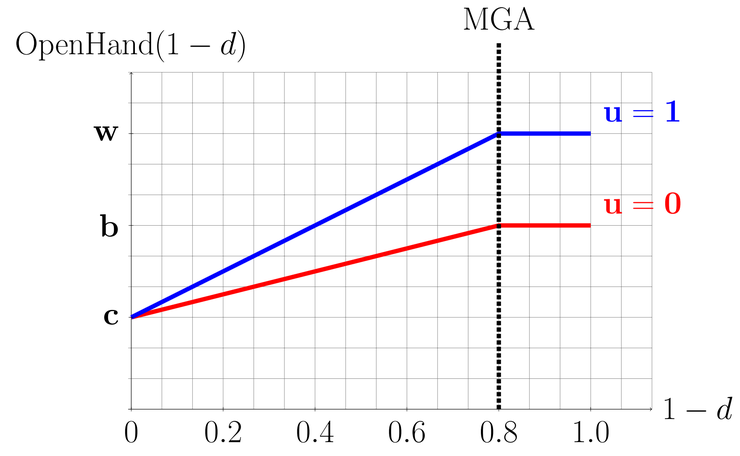
Algorithm 1: GetGoalDist(q)

return $\dfrac{\mathcal{D}(\texttt{ForwardKin}(q), T_{\text{goal}})}{\mathcal{D}(\texttt{ForwardKin}(q_{\text{start}}), T_{\text{goal}})}$

- We vary the opening of the hand as we approach according to the uncertainty of the pose of the object to grasp. If there is more uncertainty, we increase the aperture. If there is not uncertainty (theoretically) we use the default open configuration closer to the object shape.



Varying the aperture

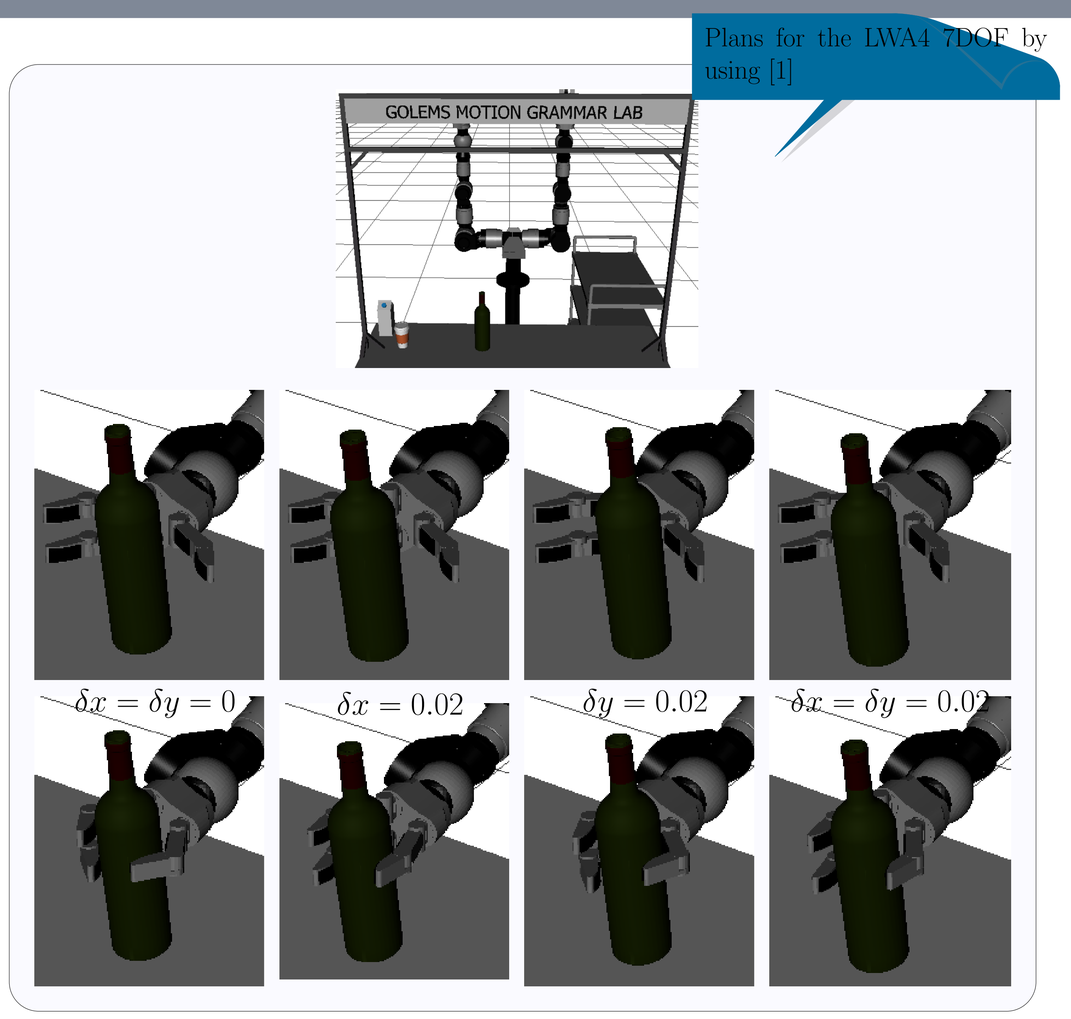


where u represents the level of uncertainty and MGA the distance at which the maximum aperture is reached.

Algorithm 3: OpenHand(d)

if $1 - d \leq MGA$ **then**
  return $\mathbf{c} + \dfrac{(1-d)}{\text{MGA}}[(\mathbf{b}-\mathbf{c}) + (\mathbf{w}-\mathbf{b})u]$
else
  return $\mathbf{b} + (\mathbf{w}-\mathbf{b})u$

Simulation Results



Discussion

- How to select a good finger open configuration?
- How to parameterize the uncertainty error? (Idea: Primitive fitting error)

References

[1] D. Berenson, S.S. Srinivasa, D. Ferguson, A. Collet, and J.J. Kuffner. Manipulation planning with workspace goal regions. In *Robotics and Automation, 2009. ICRA'09. IEEE International Conference on*, pages 618–624. IEEE, 2009.

[2] E.J. Schlicht and P.R. Schrater. Effects of visual uncertainty on grasping movements. *Experimental Brain Research*, 182(1):47–57, 2007.