Learning Task Constraints in Robot Grasping

Dan Song, Kai Huebner, Ville Kyrki, and Danica Kragic

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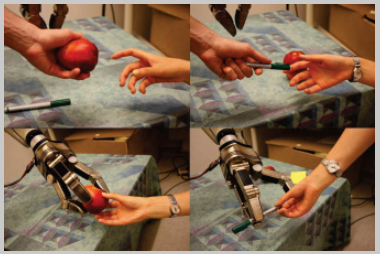
Overview



Goal:

Learning task constraints that allow grasp generation in a goal-directed manner.

Scientific Problems:

i) Identification and modeling of task -relevant features,

ii) Integration between the semantically expressed goal of a task and quantitative constraint functions.

Demonstration of Two-way Analysis using Learned Bayesian Networks:

i) Forward (causal): Action selection given task and/or object (Scenario 1, 2)

ii) Backward (diagnostic): Which task an object affords?
Which object affords a given action? (Scenario 3, 4)

Method

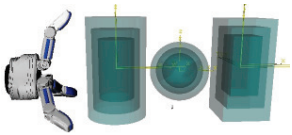
i) A large number of grasps on several objects are generated in simulation [1,2].

ii) Supervised learning is used for relating objects, grasps and tasks.

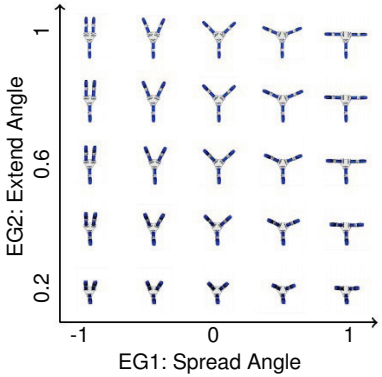
iii) Constraints are defined on object and action (grasp) features.

iv) Bayesian network (BN) is used to model probabilistic relationships between object, action features, tasks and constraints [3,4].

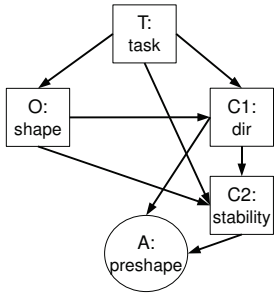
Schunk Hand & Objects



Preshape Eigengrasp (EG) Space



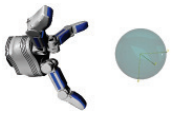
Bayesian Network



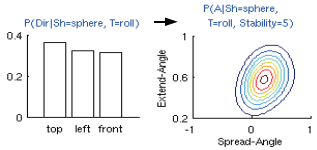
Variables	Values
T: task	*{grasp for stacking, grasp for rolling}*
O: shape	*{cylinder, sphere, box}*
C1: direction	*{top, left, front}*
C2: stability	*{1, 2, 3, 4, 5}*
A: preshape	*2D Eigengrasp space*

Application

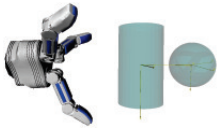
Scenario 1: Grasping a ball for rolling with Schunk hand



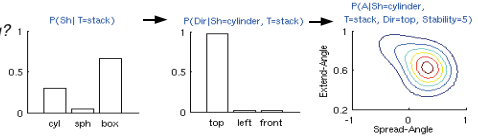
i) Is approach direction constrained ? -- No !
ii) Select most stable preshape



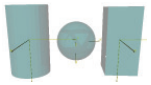
Scenario 2: Between a cylinder and a ball, selecting one object for stacking

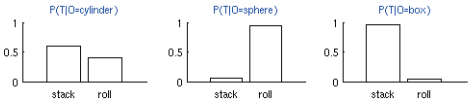


i) Which object in the scene is best for stacking? -- Cylinder
ii) Is approach direction constrained? -- Yes, top
iii) Select most stable preshape



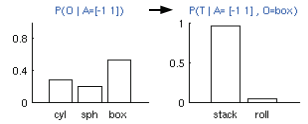
Scenario 3: Inferring a task afforded by the object





Scenario 4: Which object can be grasped or what task can be performed by a specific hand preshape?

i) Which object is best for this preshape ? -- Box
ii) Which task should be performed ? -- Stacking



Conclusions

i) Task constraints can be used to bridge the gap between the high-level symbolic reasoning and low-level sensory representations

ii) Generative models are suitable for inferring regions of stable grasps. The framework can also handle the uncertainty in real world applications.

iii) The idea is to integrate this work in goal-directed imitation learning [5].

iv) The challenge can be to collect enough training data for learning more complex BNs in real world applications.

References

[1] K. Huebner and D.Kragic, Grasping by parts: robot grasp generation from 3D box primitives. *Poster, CogSys 2010.*
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CONTACT INFORMATION
Dan Song, Ph.D.
CSC-CAS/CVAP, KTH
Teknikringen 14
SE 100 44 Stockholm
Sweden
Tel: +46 8 790 6646
Email: dsong@kth.se