Interactive Generalized Penetration Depth Computation for Rigid and Articulated Models using Object Norm

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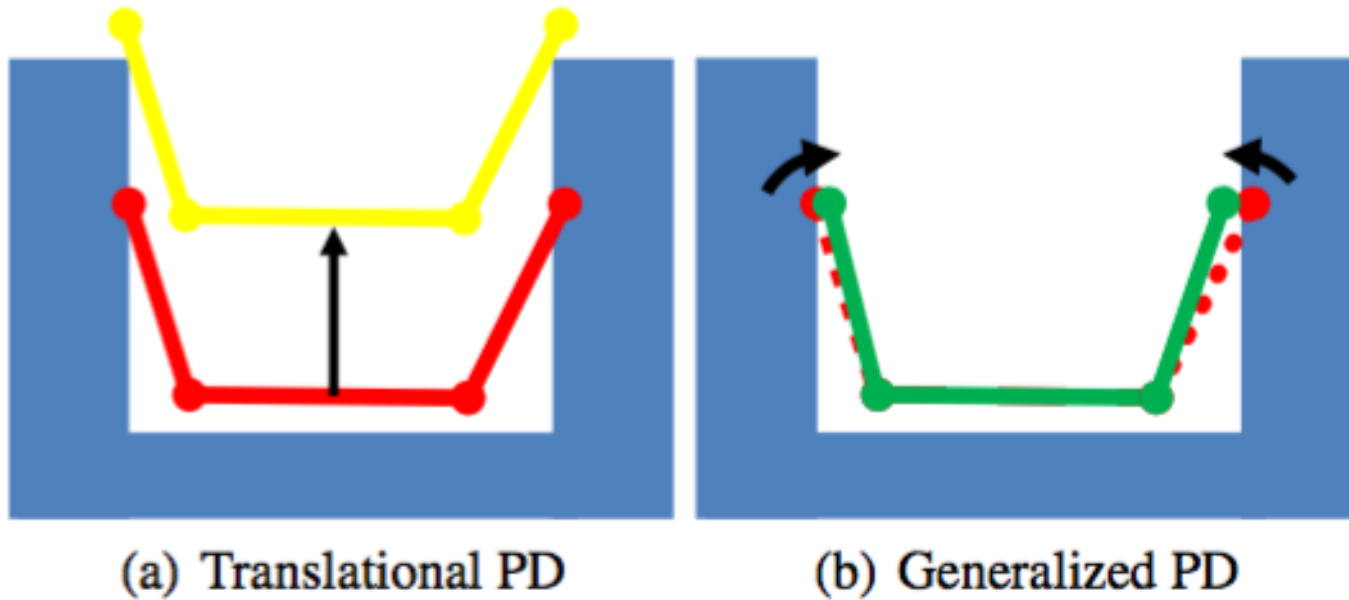
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28.10.2015

Overview – key topics

- Penetration depth

- Collision detection

- Articulated models (having joints)

- Algorithms

- Object norm metric

Introduction – Main problem

(a) Translational PD   (b) Generalized PD

Main goal

- Create algorithm to accurately approximate generalized penetration depth (PDg) between two overlapping rigid or articulated models

Previous work

- Translational Penetration Depth
  - relatively slow
  - do not run at interactive rates

- Generalized Penetration Depth
  - rather slow for interactive applications
  - not clear whether they are applicable to articulated models

Work

- Object norm - general formulation of distance metric
- Generalized PD computation
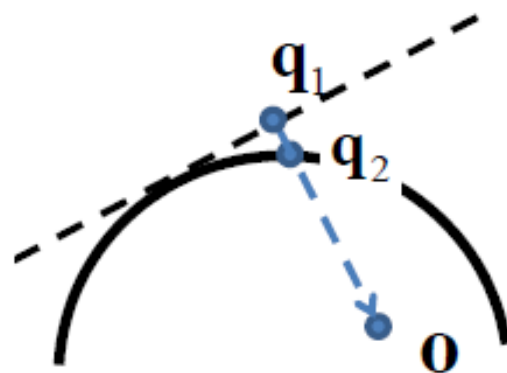
Generalized PD computation

- Free-configuration Selection

- Contact-space Projection

- Constrained Optimization
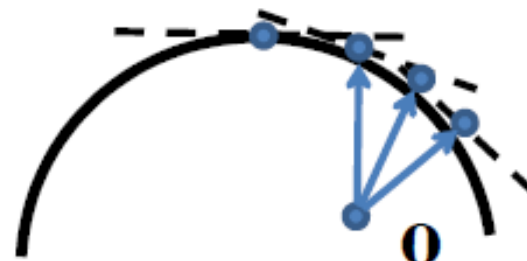
- Re-projection
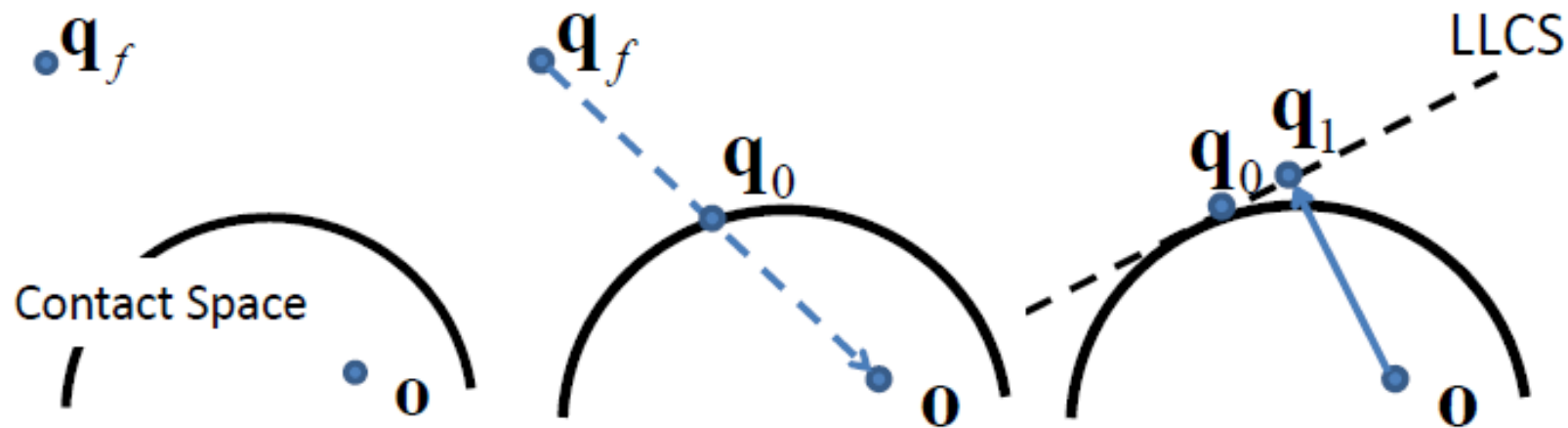
(a) Free-conf. selection   (b) Contact space proj.   (c) Constrained optimization

(d) Re-projection   (e) Iteration

Suggested applications

- Retraction-based motion planning

- Physically-based animation

- Data-driven grasping

Interactive Generalized Penetration Depth (PDg) Computation
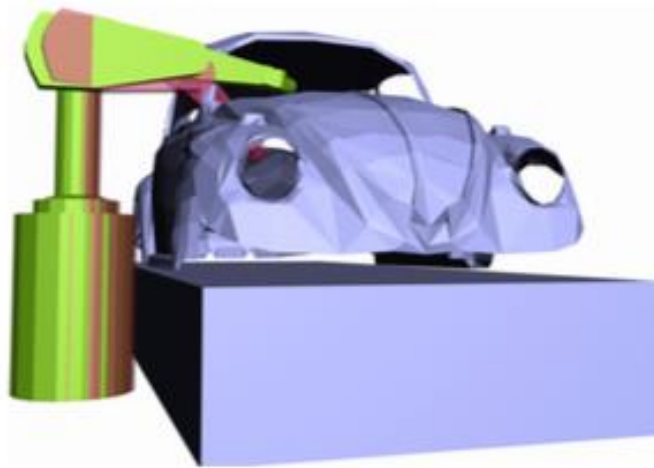

(a) Spoon/Cup

(e) Grasping

PDg Computation for Articulated Models

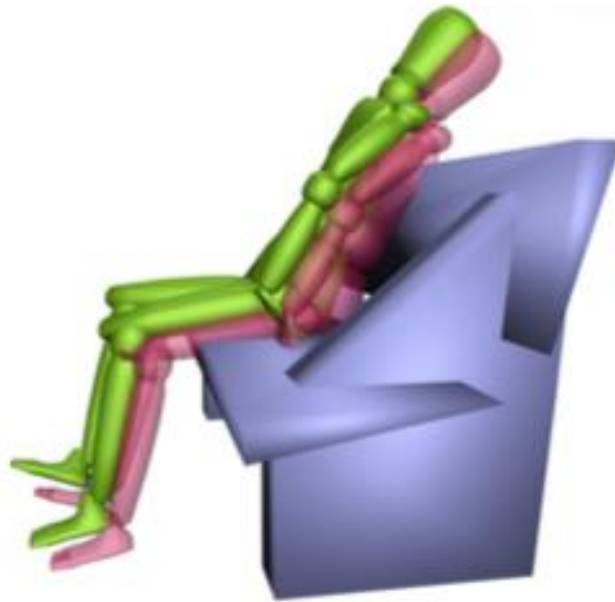(a) Puma1   (b) Puma2   (c) Hand

Finding Collision-free Configurations for Articulated-body Dynamics

(a) Bench   (b) Cup

Conclusion and key ideas

- Real-time algorithm to compute generalized penetration depth for rigid and articulated models

- General formulation of distance metric, the object norm

- Different applications - motion planning, physically-based animation and grasping

Future work

- Extension of the generalized PD computation to multiple bodies

- Integration into constraint-based dynamics

- GPU-based or parallel implementations

The End