Example Based Dynamic Deformation

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Outlines

- Motivation & Objective
- Related Work
- Method
- Results & Demo

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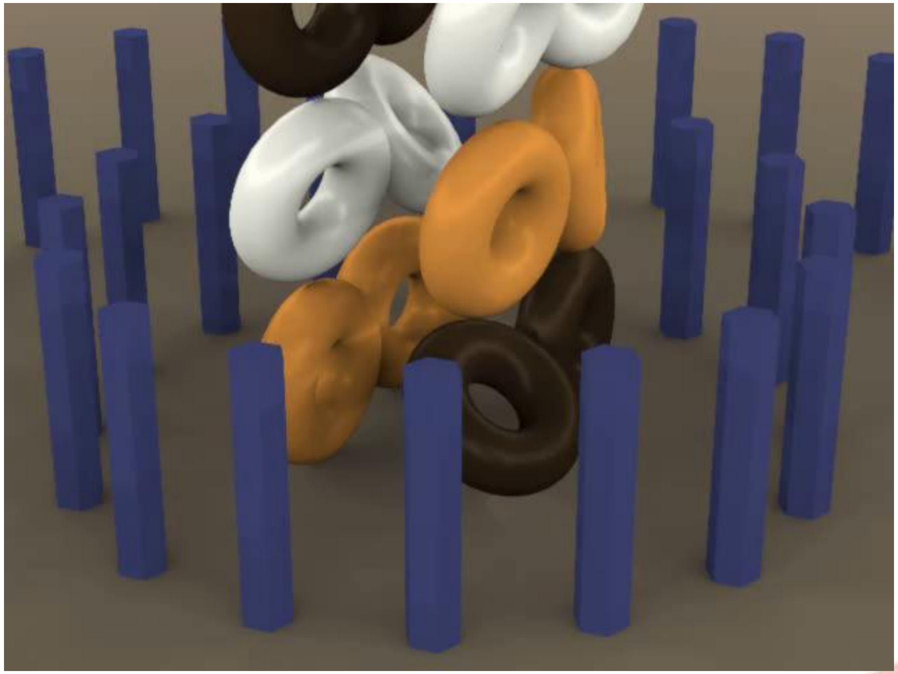
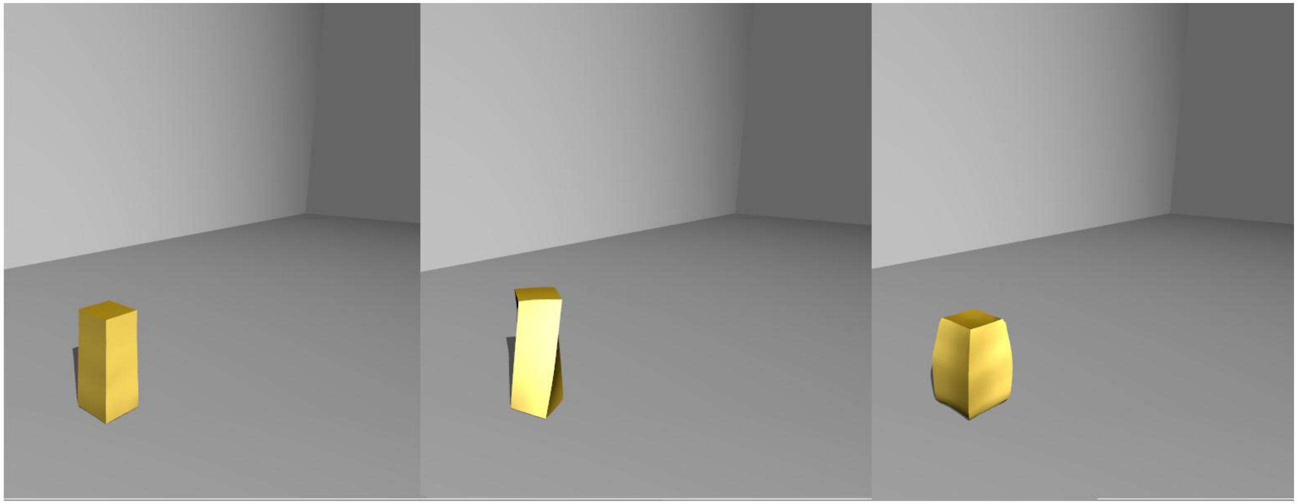
Motivation & Objectives

- Physically based deformation is good:
  - Realistic
  - automatic



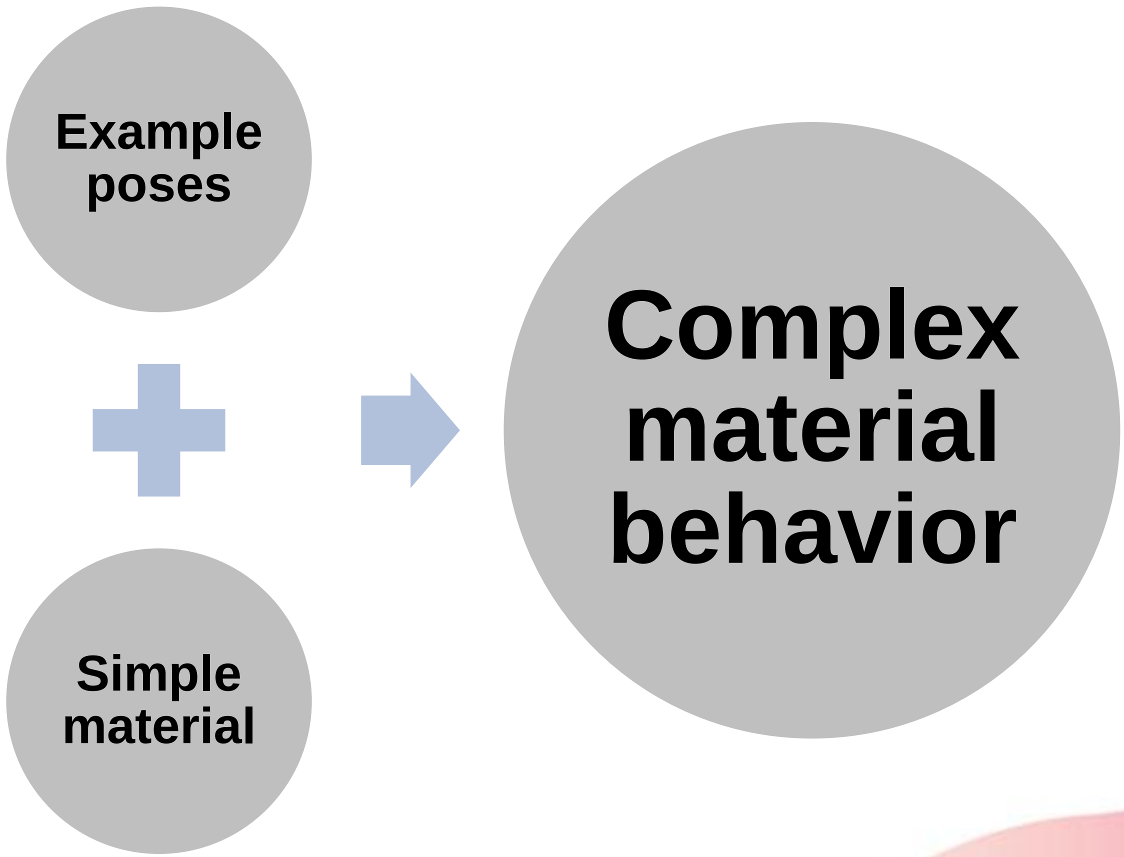
Motivation

- However, a physically based deformable model relies on the material model and its parameters
  - Young's modulus , Poisson Ratio, etc
  - Large amount
  - Unintuitive to tune to obtain desired material behavior



Objective

- Intuitive and fast method to simulate complex material behavior



Related Work

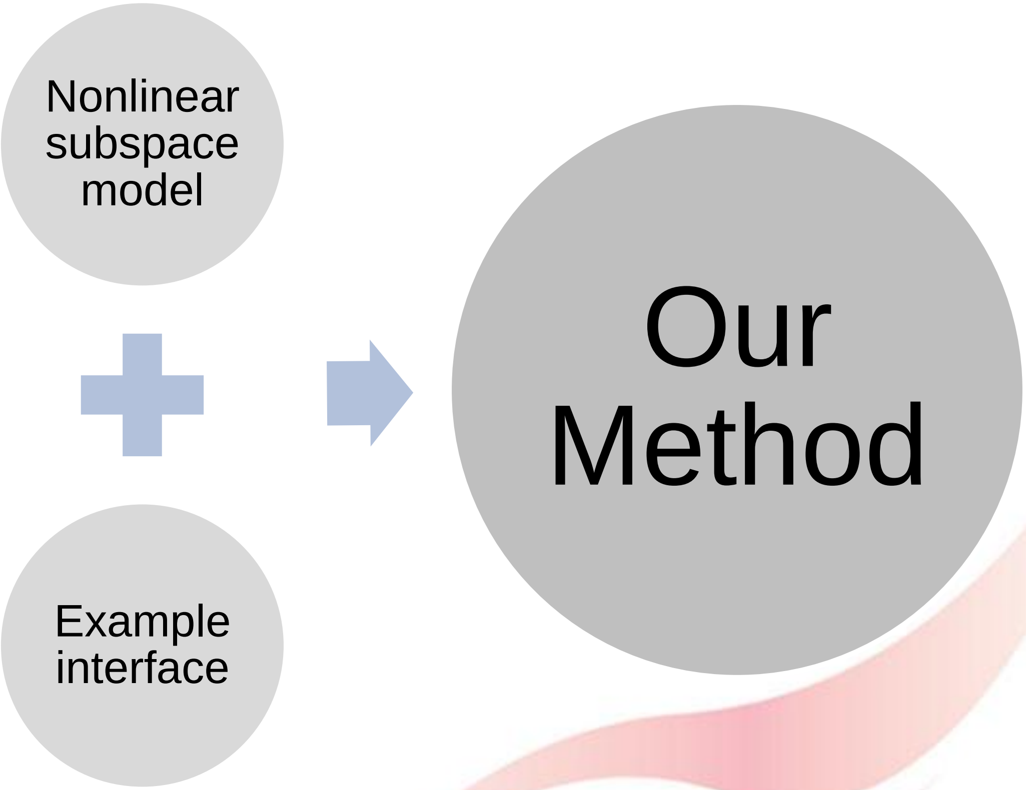
- Example-based Elastic Material [Sebastian Martin,2011]
  - Using a force to encourage the object deforming towards the example poses
  - First try to use example poses to simulate complex nonlinear material behavior

- Drawback
  - Time consuming
  - Hardly run faster than 2fps

Method

- Encourage the object deform towards example poses by reducing the stiffness of the corresponding deformation direction

- Subspace model for speed

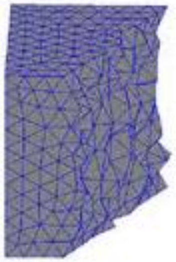


Dynamic Motion Equation

- A typical Motion Equation:

$$M\ddot{u}(t) + R(u(t)) = f(t)$$

- u is the displacement vector
- The size of u is usually large
- R is the internal force depends on the material parameters



Subspace model

- Parameterize u with a small size of vector q
- The most used is:

$$u = Uq$$

U **is the deformation basis**

$$M\ddot{u} + R(u) = f$$

$$\downarrow$$

$$\ddot{q}(t) + \tilde{R}(q(t)) = \tilde{f}(t)$$

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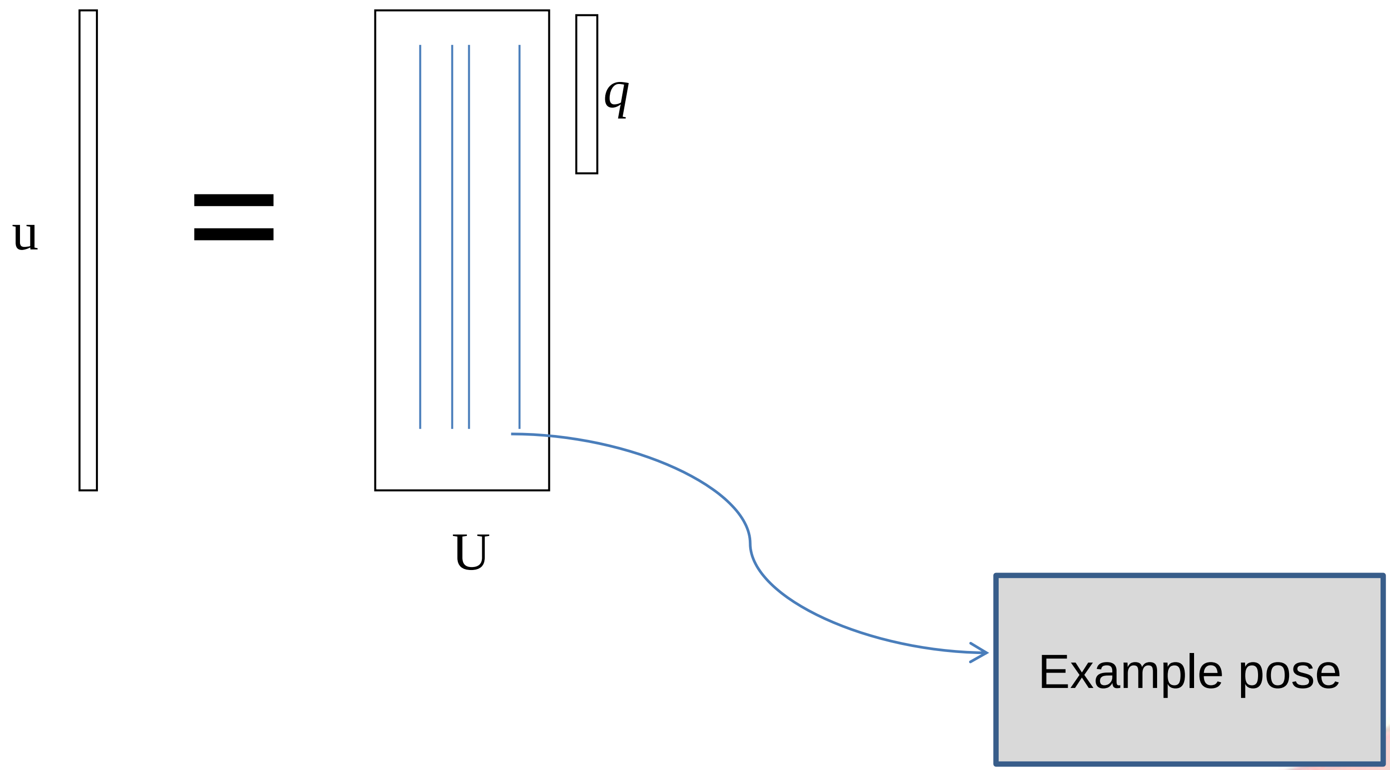
Example Control

- an example pose is identifies as a single mode in the deformation basis



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Example Control

$$\ddot{q}(t) + \tilde{R}(q(t)) = \tilde{f}(t)$$

- Reduce the internal force corresponding to the example pose can encourage the object deform towards the example pose.
  - Just multiply a scaling factor

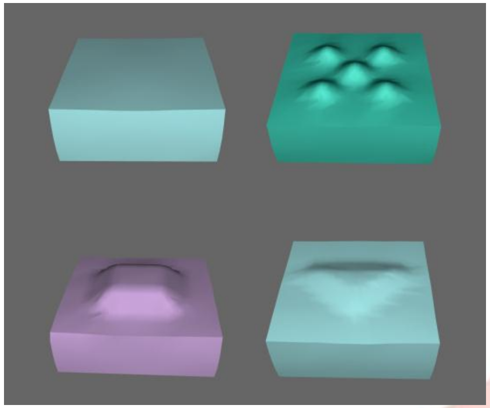
- However, not applicable with the usual linear subspace
  - result in linear interpolation of the example poses

Nonlinear subspace model

- Nonlinear blending of the deformation modes
- $u = u(q)$:
  - Linear blending in a feature space:

$$\hat{u} = \hat{U} q$$

Demo



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Results

- Timing
- Speeded with GPU

Number of vertices	Number of tetrahedron	Size of deformation basis	fps
1780	7443	20	161.2
2252	6410	20	175.3
3082	9357	20	108.3

Thank you !