

W4162



COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

Advanced Computer Graphics

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Fall 2014

Course Overview

Goal:

Know the state of the art

Prepare for scientific research

In COMS W4162

- You will
 - explore advanced topics in computer graphics
 - learn related math
 - read and discuss research papers
 - implement advanced algorithms
- You will *NOT*
 - touch every topics of graphics (only selected topics)
 - learn OpenGL

Topics in Computer Graphics

- Traditionally, **visual computing**
 - Imaging: processing 2D images
 - Modeling: representing 3D objects
 - Rendering: from 3D to 2D
 - Animation: from static to dynamic

Imaging

- Closely related to computer vision
 - Filtering, resampling, warping
 - Computational photograph
 - (e.g., Lytro camera)
- Video processing

<https://www.youtube.com/watch?v=ONZcjsIPjmk>

Rendering

- Photorealistic image rendering
 - Polygon rendering pipeline
 - Raytracing





Indigo by *StompinTom*

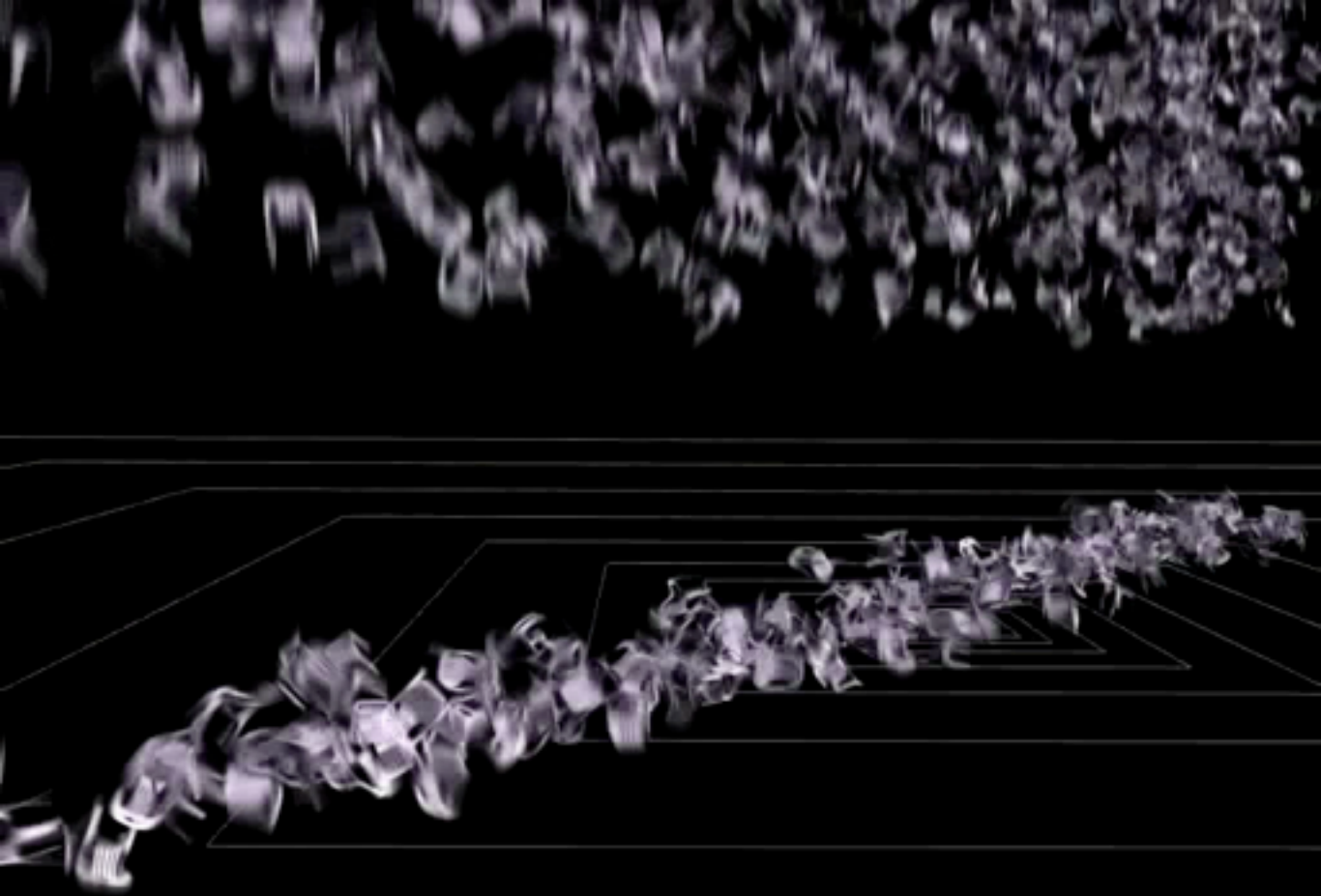
Modeling

- 3D object representation
 - Polygon meshes
 - mesh processing (simplification, smoothing, etc.)
 - shape analysis (segmentation, symmetry detection, etc.)

https://www.youtube.com/watch?v=w_r-cT2jngk

Animation

- Physically-based simulation
 - rigid-body
 - deformable (cloth, hair, rubber)
 - fluid and air



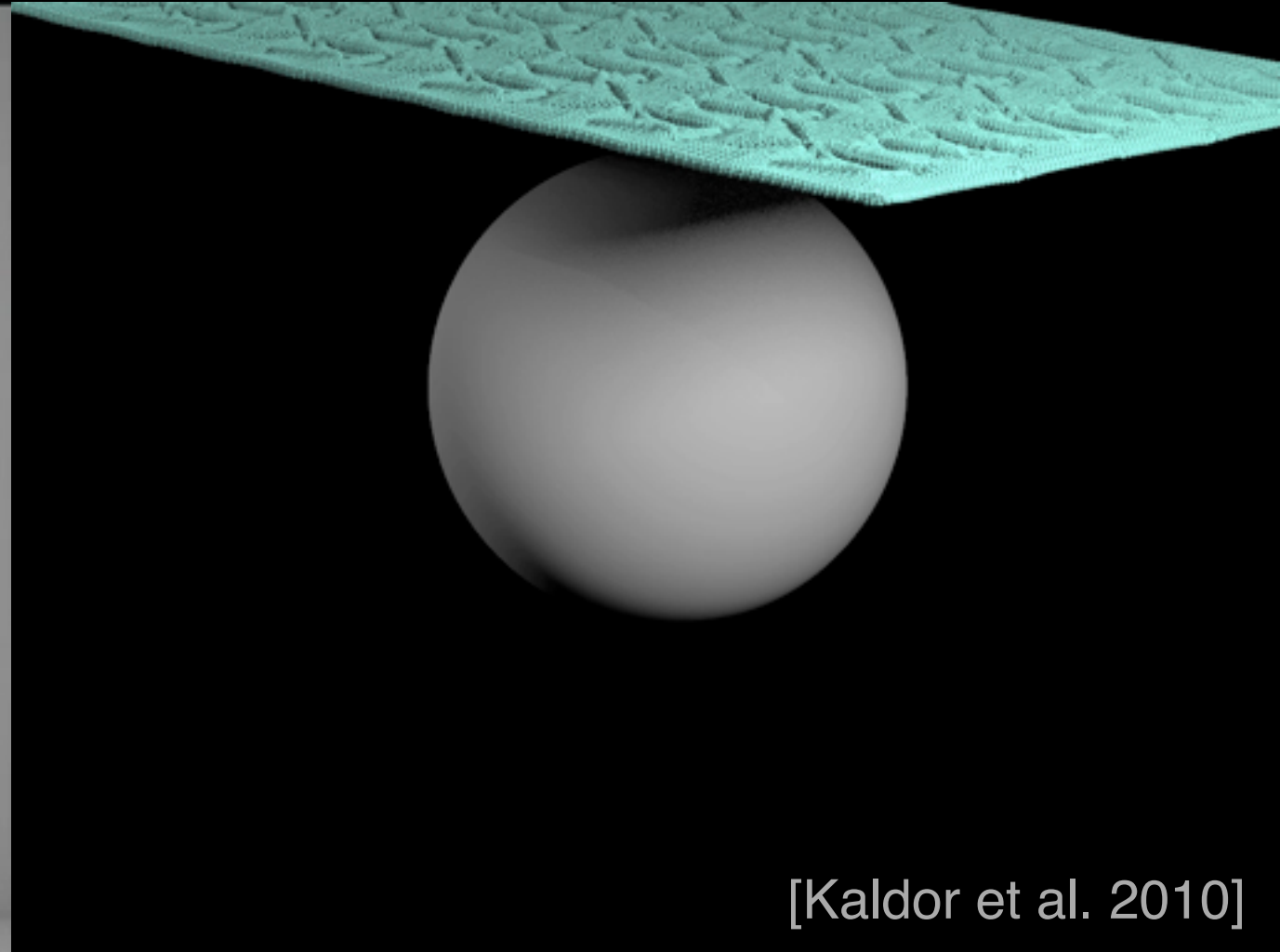
[James & Pai 2004]



[Losasso et al. 2008]



[Goldenthal et al. 2007]



[Kaldor et al. 2010]

The field is growing ...

Topics in Computer Graphics

- Traditionally, **visual computing**
 - Imaging: processing 2D images
 - Modeling: representing 3D objects
 - Rendering: from 3D to 2D
 - Animation: from static to dynamic
- **Computational design (3D Fabrication)**
- **Sound synthesis / simulation**

<https://www.youtube.com/watch?v=BjZ7CV6gill>

Selected Topics

- Image rendering
 - Monte Carlo ray tracing, Photonmapping
- Texture synthesis
- Mesh processing
 - Laplacian mesh editing, Simplification
- Finite element simulation
 - Basic FEM, static equilibrium, reduced simulation
- Fluids
 - SPH, vortex method

Course Mechanics

Enjoy the class!