Geometric Modeling

2015

Introduction

TU Delft

Who's who?

Lecturer

Klaus Hildebrandt
k.a.hildebrandt@tudelft.nl

EEMCS Building , Room 11.270

And you?

- Name
- Where did you do your Bachelor?
- In what program are you now?
- Took a Computer Graphics course already?

Time & Location

Lecture:

- Tuesday 10:45-12:30 h, EEMCS – Lecture hall L

Tutorials:

- Wednesday 15:45-17:30 h, TBM – PC B

- **Tomorrow: Lecture instead of Tutorial**

Registration

Register in Blackboard

- Please *register* within the *first week* of the lecture

Register with me

- Email to: k.a.hildebrandt@tudelft.nl
- Register on or before April 28th, 2015 (Tuesday next week)

Assignments & Exam

Theoretical Assignments

- Ungraded
- Solutions will be discussed in the tutorial courses
- Helpful for deepen understanding

Practical Assignments

- Programming assignments
- Graded (30% of the final grade)

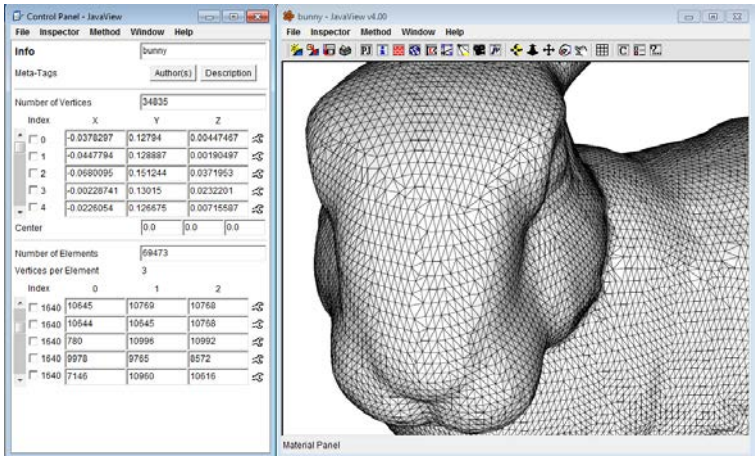
Final Exam

- Graded (70% of the final grade)

Practical Assignments

Practical Assignments

- Groups of three students
  - Form groups yourselves
  - Let me know: Email to k.a.hildebrandt@tudelft.nl



Software

- JavaView (www.javaview.de)

First Tutorial Course:

- There will be an introduction to the software framework in the tutorial on Wednesday, 29th April
  - Help forming of groups, if needed

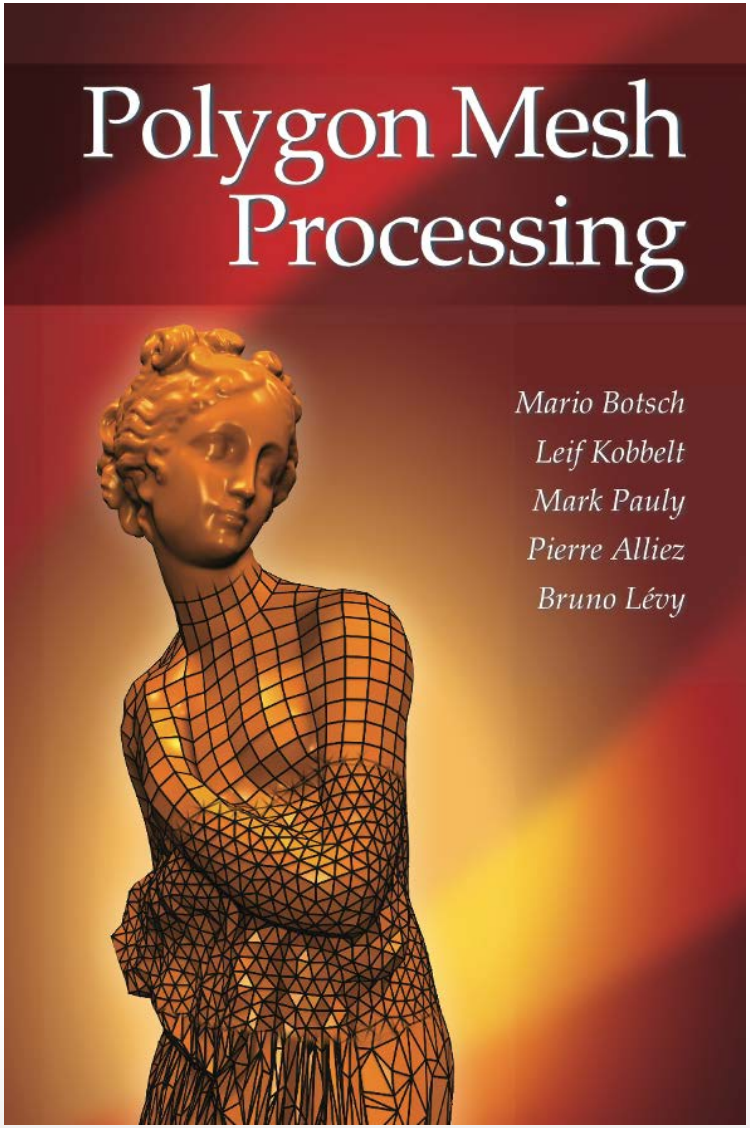
Practical Assignments

Practical Assignments: Grading

- Grading in personal interviews
- 20 min slots
- Group must *show up entirely*
  - Only for the 20min, not the whole time
- Everybody is graded individually, based on:
  - The group's implementation
  - Personal knowledge about the implementation
  - Everybody must be able to *explain all of the code*

Recommended Literature

Textbook: Mesh Processing



Mario Botsch, Leif Kobbelt, Mark Pauly, Pierre Alliez, Bruno Levy

Polygon Mesh Processing

AK Peters/CRC Press 2010

SIGGRAPH Course

Course notes available as pdf

Mario Botsch, Mark Pauly, Christian Rössl, Stephan Bischoff, and Leif Kobbelt
Geometric modeling based on triangle meshes
In SIGGRAPH Course Notes, Boston, USA, 2006, ACM

Mario Botsch, Mark Pauly, Leif Kobbelt, Pierre Alliez, Bruno Lévy,
Stephan Bischoff, and Christian Rössl
Geometric modeling based on polygonal meshes
In SIGGRAPH Course Notes, San Diego, California, 2007, ACM
revised course notes.

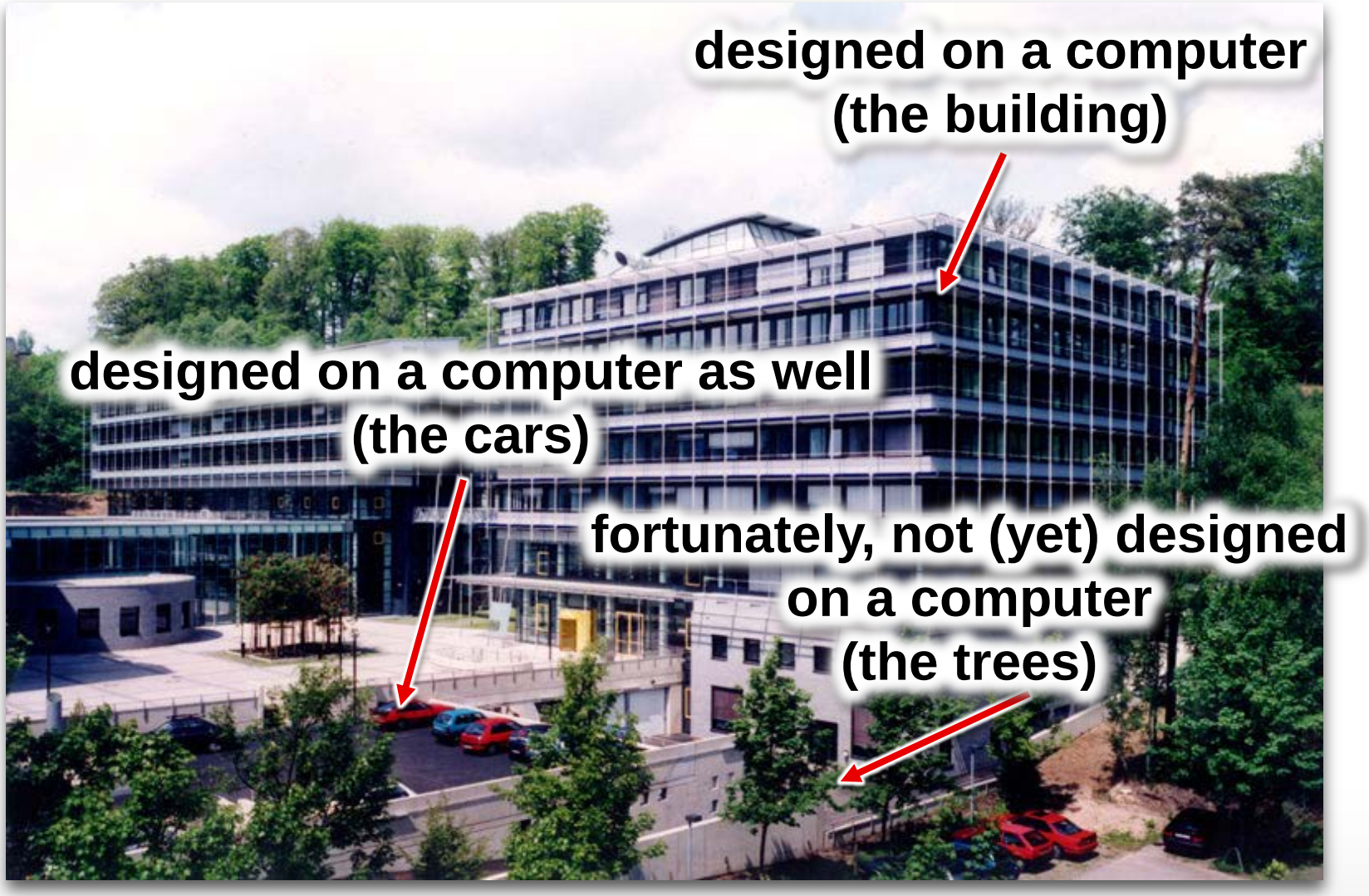
Recap Math Topics

Recap: Linear Algebra, Analysis & Numerics

Refer to your lecture notes / standard math textbooks

Motivation

The Modern World...



Impact of Geometric Modeling

We live in a world designed using CAD

- Almost any man-made structure designed w/computers
  - Architecture
  - Commodities
  - Your bike, car
  - …
- <advertising> Our abilities in geometric modeling shapes the world we live in each day. </advertising>

Different Modeling Tasks

Computer Aided Design

- Precision Guarantees
- Handle geometric constraints exactly (e.g. exact circles)
- Modeling guided by rules and constraints

[aimatshape.net]

Different Modeling Tasks

Photorealistic Rendering

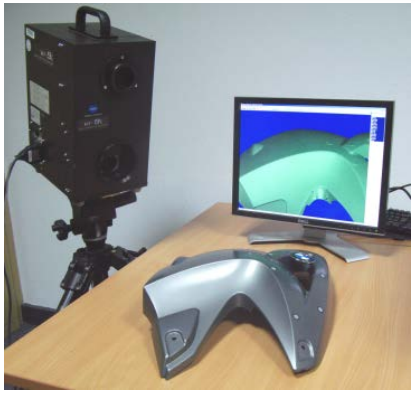
- Has to “look” good
- Ad-hoc techniques are ok
- Using textures & shaders to “fake” details
- More complexity, but less rigorous

[Deussen et al: Realistic modeling and rendering of plant ecosystems, Siggraph 1998]

Geometry Processing

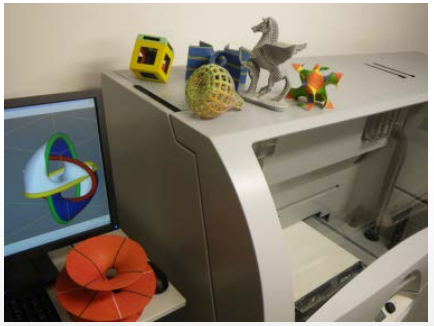
A rather new area

- Captured Geometry
  - 3D scanners
  - Depth cameras
  - …
- Digital Fabrication (3D-Printing)
- Rendering



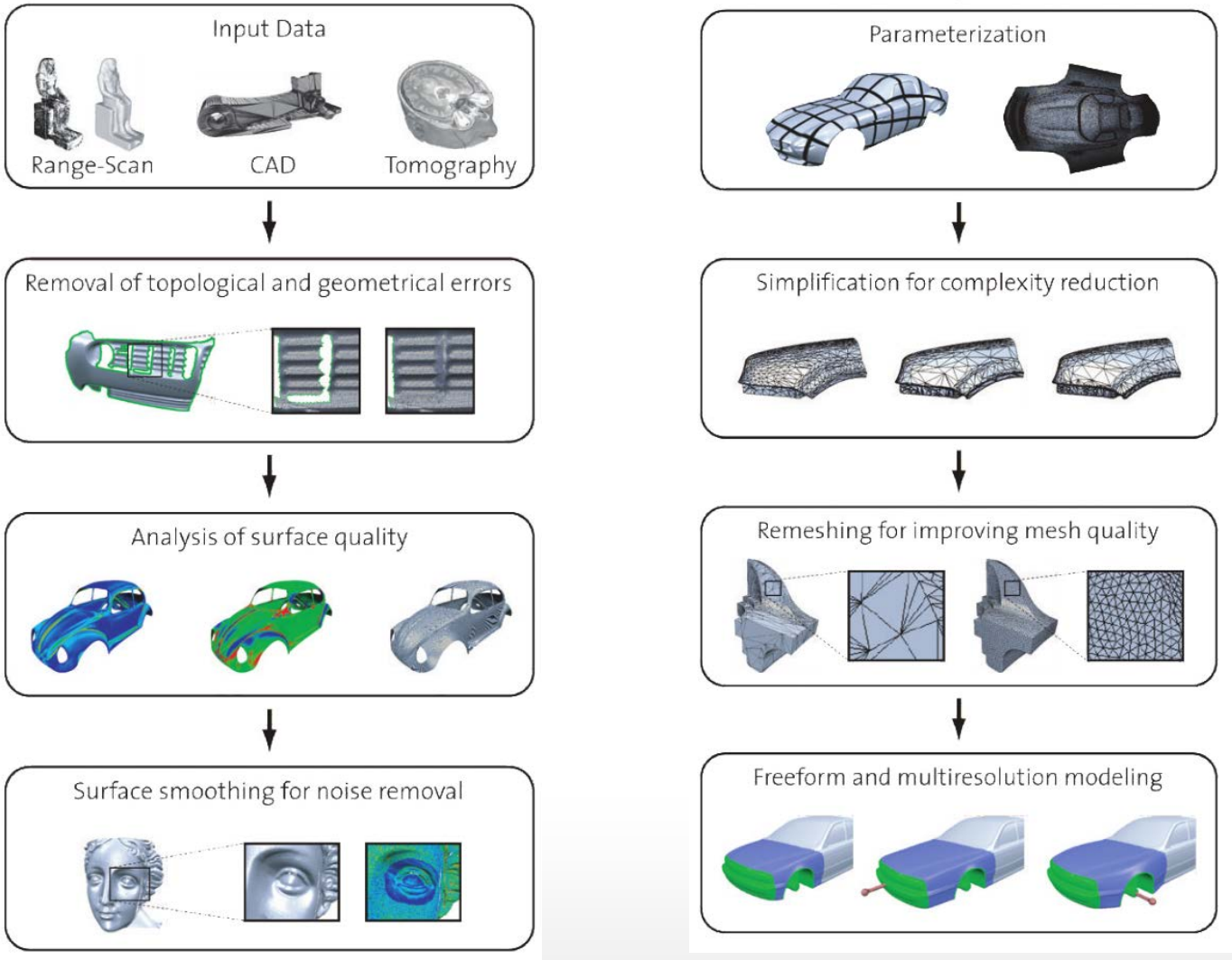
Between acquisition and production lies

Geometry Processing



Photoshopping Geometry

Geometry Processing Tasks

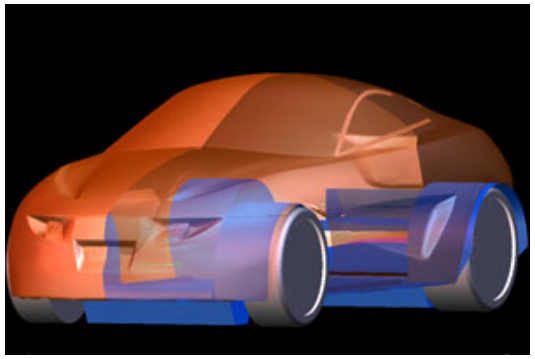


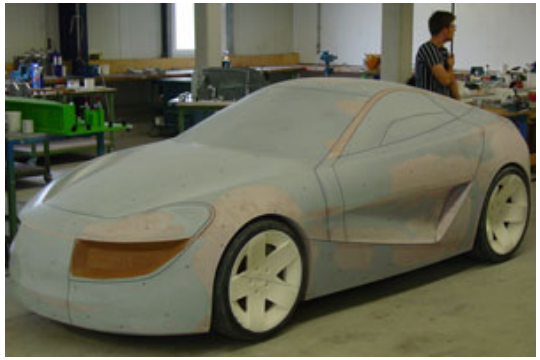
[L. Kobbelt]

Prototyping

Designing Shapes



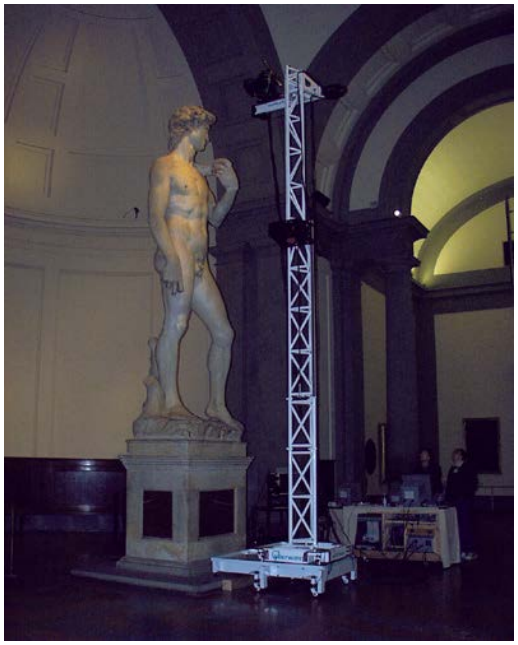




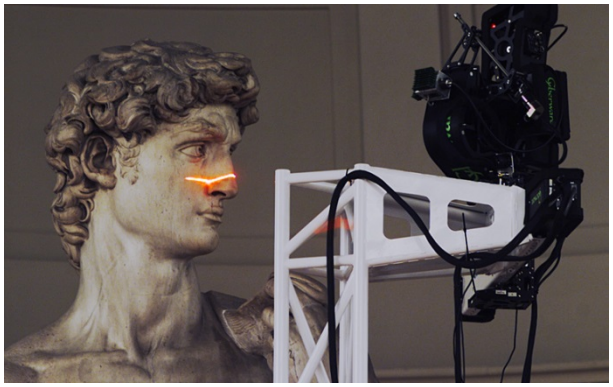

[Tebis AG]

Cultural Heritage

Example: The Stanford “Digital Michelangelo Project”



scanning



scanning

rendered
reproduction

[Levoy et al.: The Digital Michelangelo Project, Siggraph 2000]

Digital Fabrication

Customized 3D-Printing

3D-Selfies

Printing Services

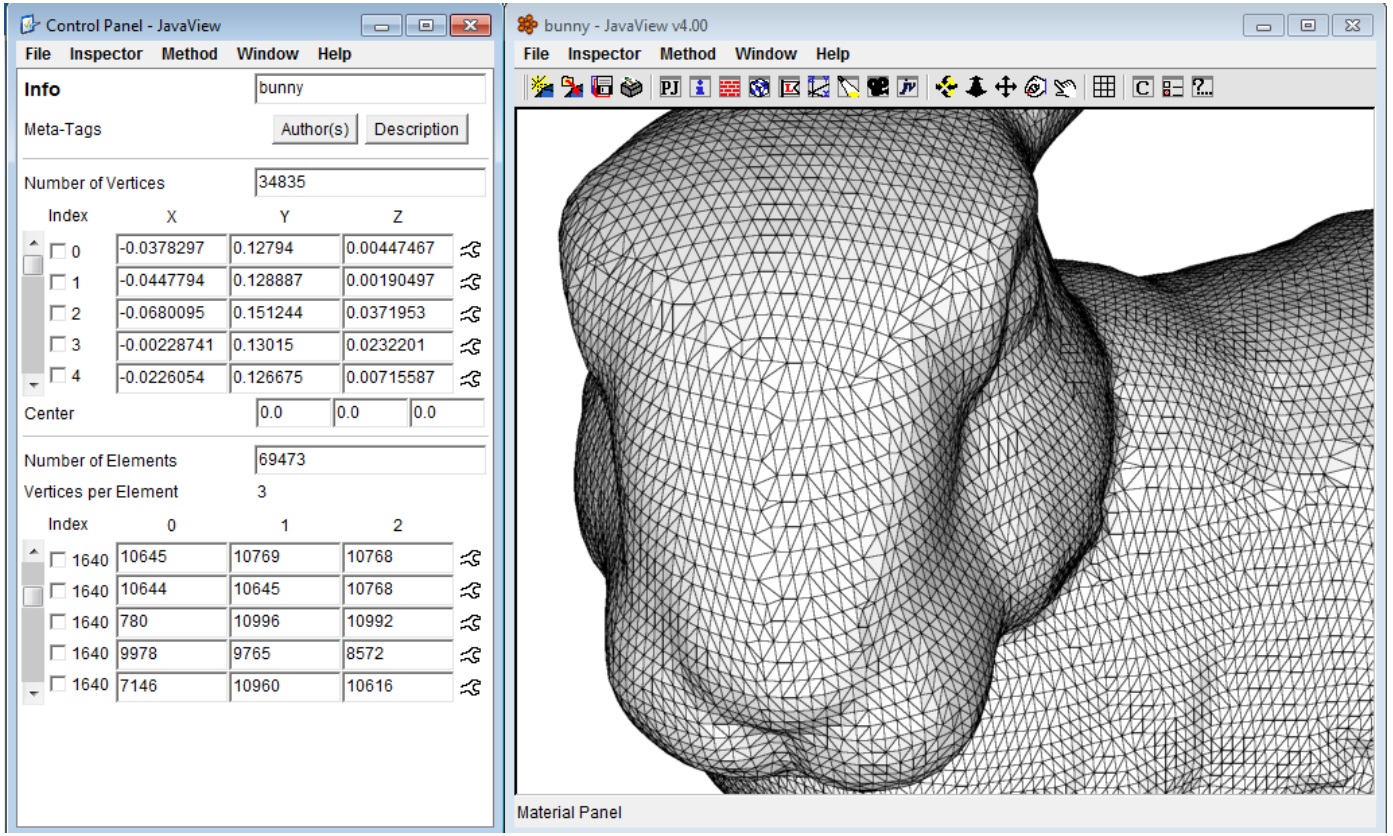
Spinning tops

Lecture Overview

Topics (Examples)

Digital Surfaces

Focus: Triangle meshes



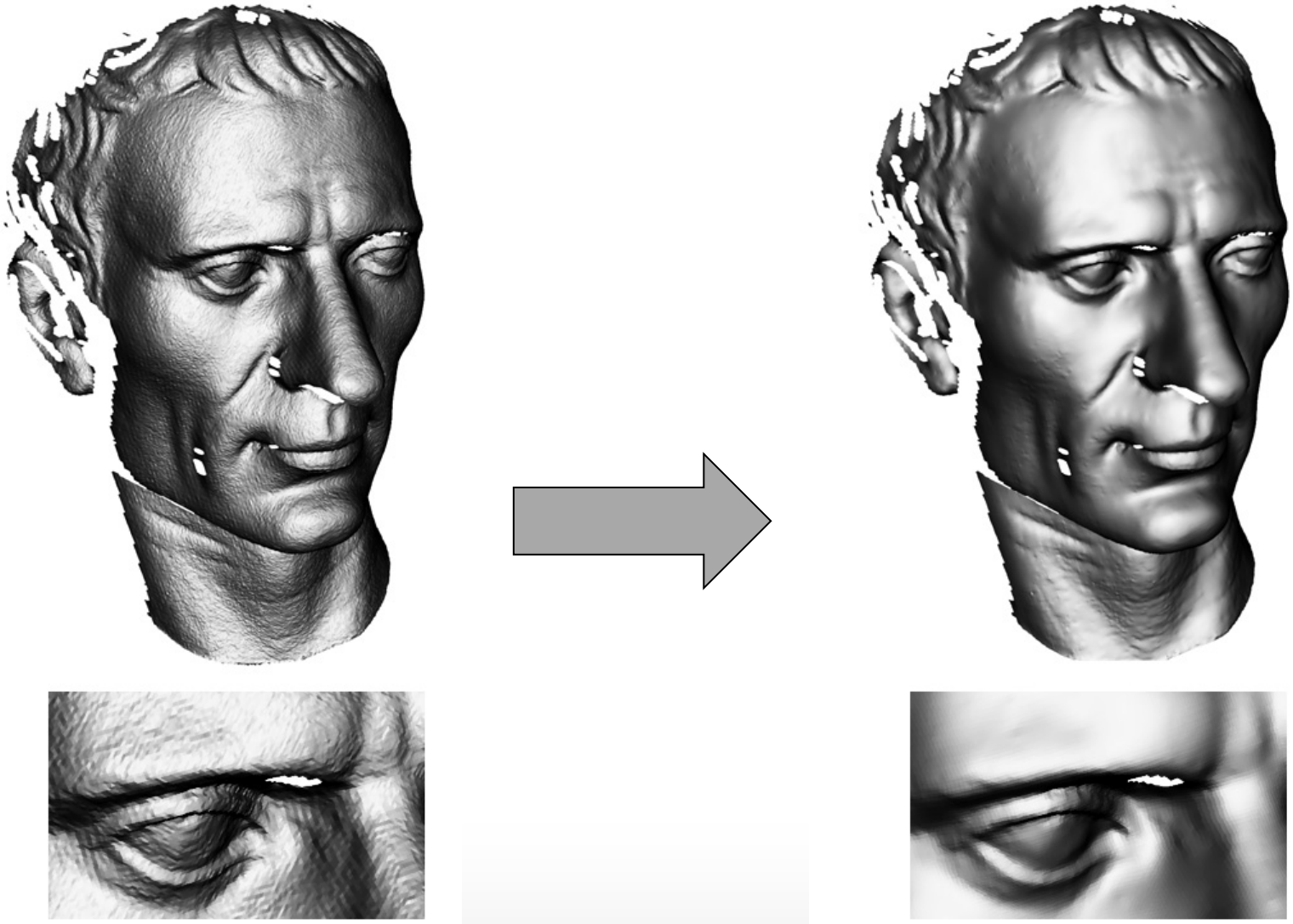
Background

Geometric Concepts

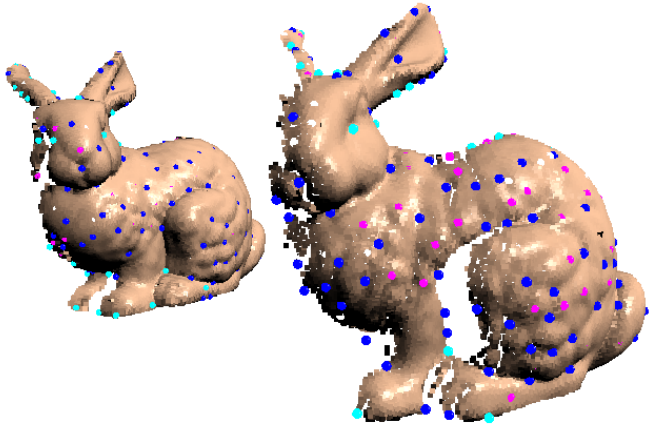
- Topology
- Curvature
- Laplace-Beltrami operator (the swiss army knife of geometry processing)
- Deformation
- Vibration
- …

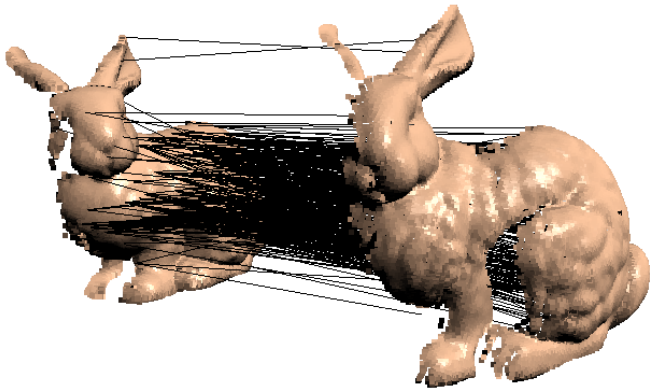
[K. Crane]

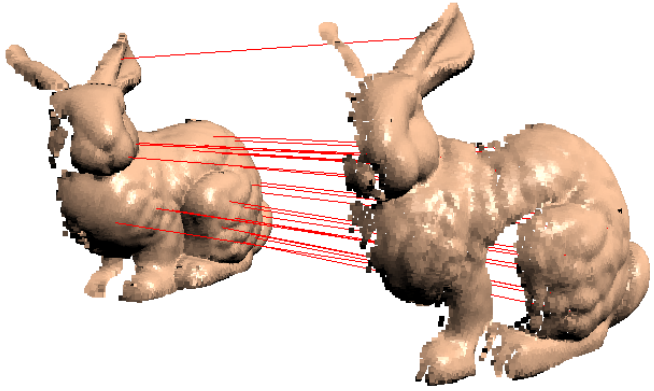
Smoothing & Noise Removal

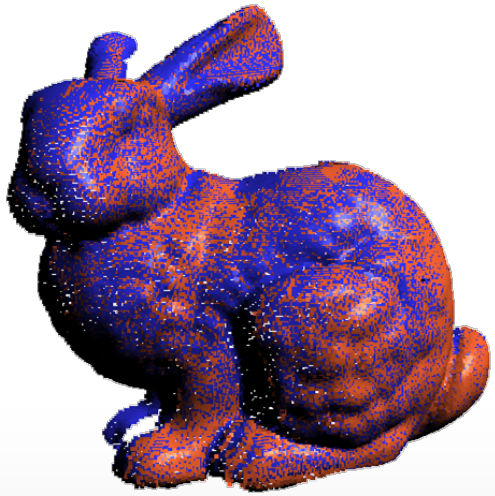


3D-Scan Registration



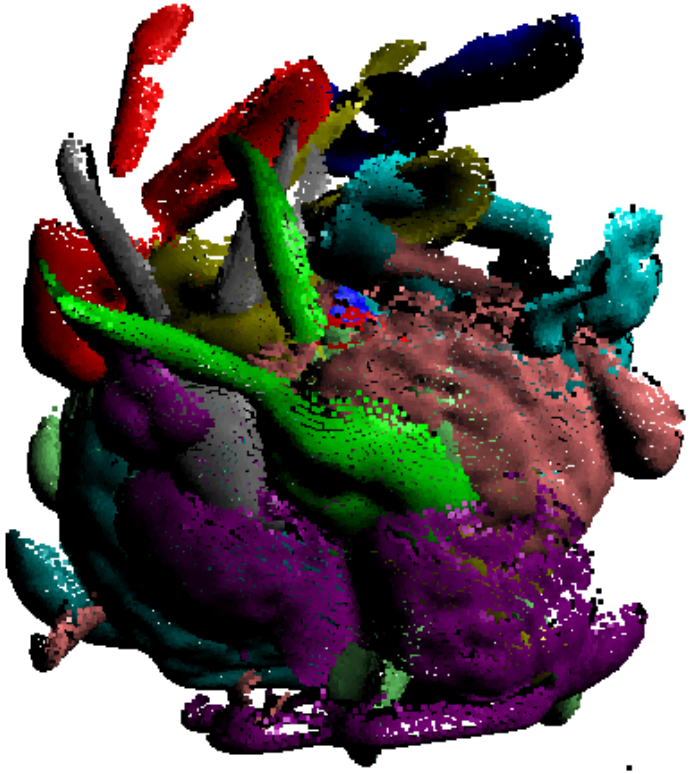






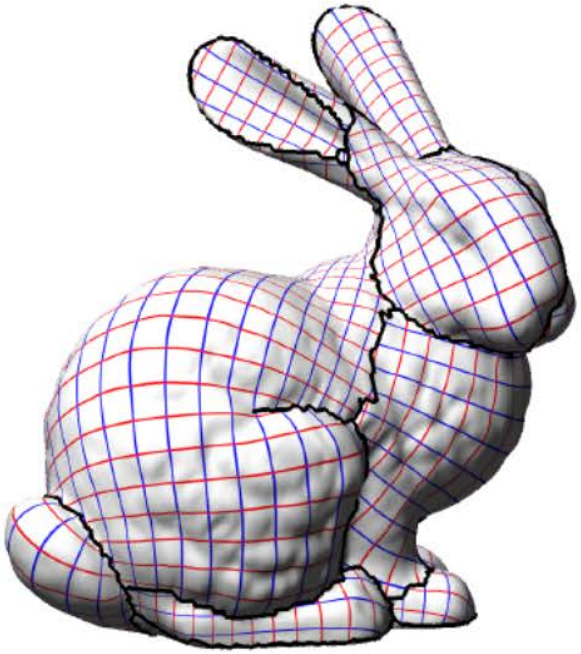
[M. Bokeloh]

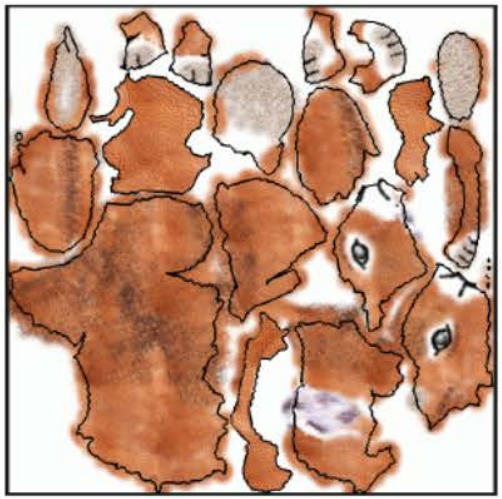
3D-Scan Registration



[M. Bokeloh]

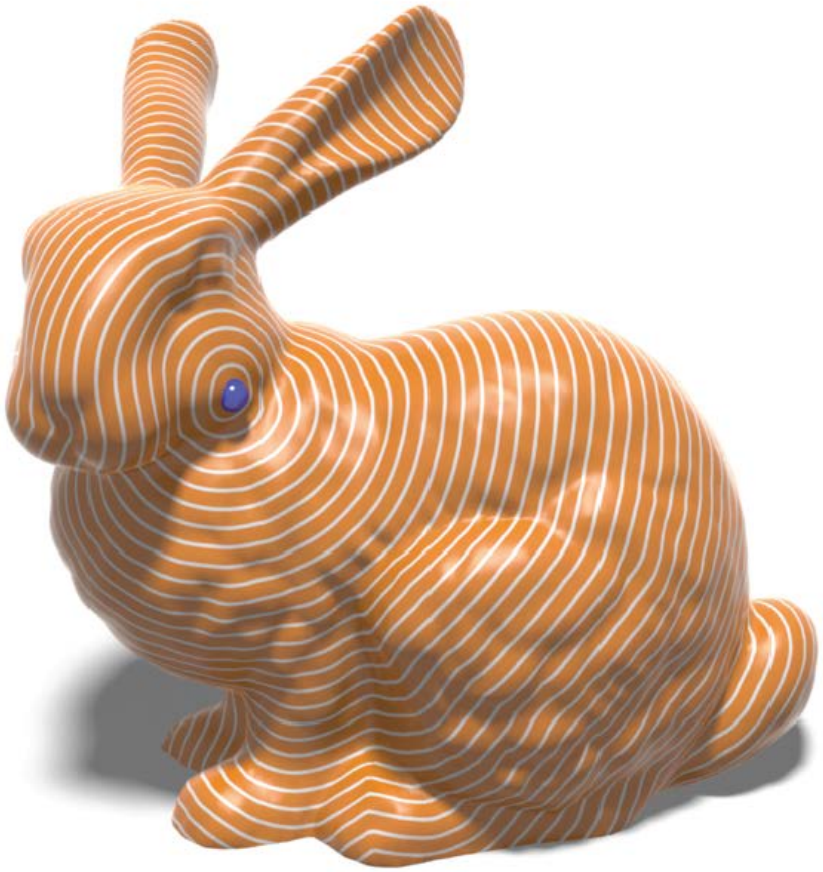
Parametrization





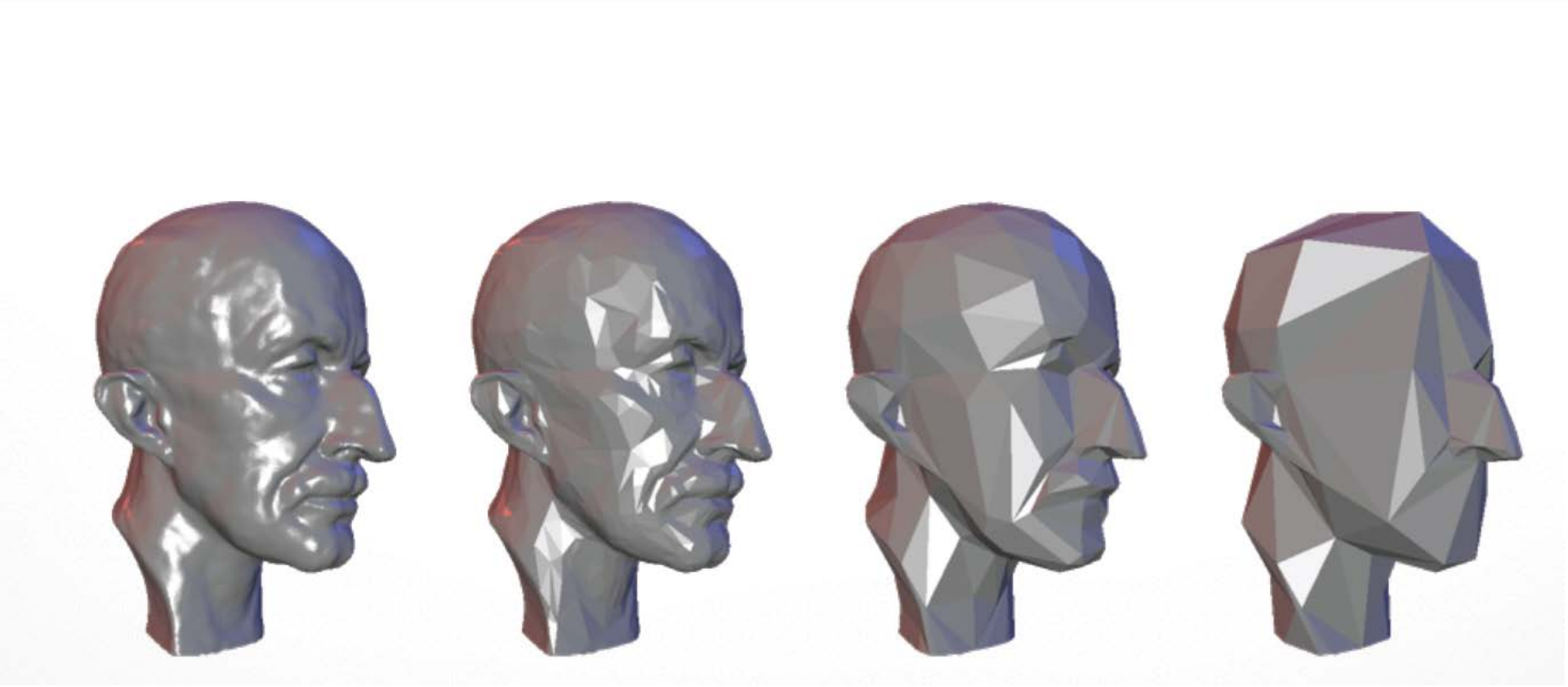
[B. Levy]

Computing Geodesic Distances



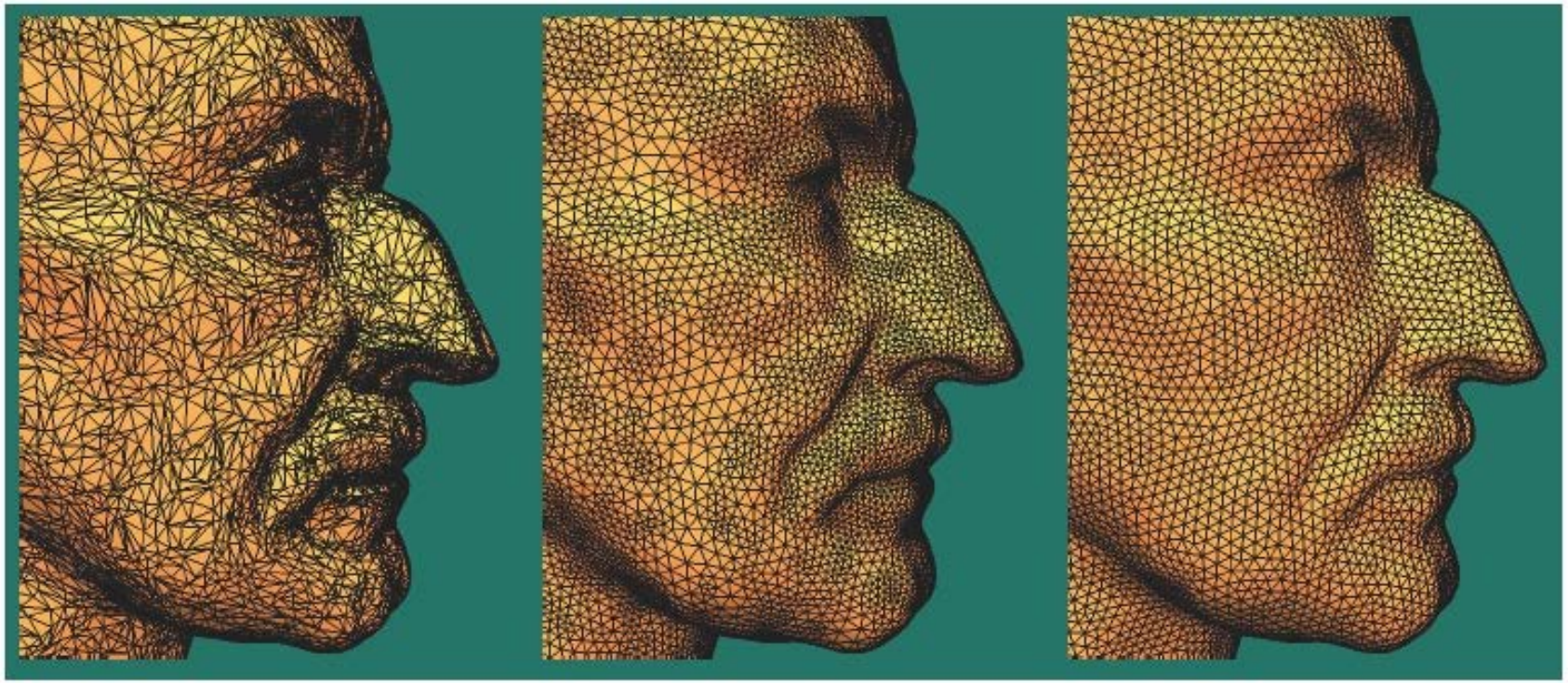
[K. Crane]

Simplification



[C. Roessl]

Remeshing



[C. Roessl]

Surface Modeling

Interpolation

Interpolation