# CSCI 599: Digital Geometry Processing Spring 2015

#### Hao Li

#### http://cs599.hao-li.com



# USC Graphics





#### **Geometric Capture [Lab]**

#### http://www.hao-li.com



# The Team

#### Instructor

- Hao Li, <u>hao.li@usc.edu</u>
  - Office: SAL 244
  - Office hours: Tuesday 2-3PM





#### Assistants

- Kyle Olszewski, olszewsk@usc.edu
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#### About Me



#### Industrial Light & Magic



#### Science, Engineering, & Art



# **USC**Viterbi

School of Engineering







USC School of Cinematic Arts



**USC**Games

#### High Tech & Capital of Entertainment

# Disney DreamWorks ACILVISION Google Activision



# Introduction



# **Target Audience**

- PhD students, MSc students, Advanced undergraduates
- **Computer Science**, Computer Engineering, Mathematics, Physics, Game Program, Biomedicine, Bioengineering, etc.
- Computer Graphics, Computer Vision, Robotics, Machine Learning, Signal and Image Processing, Medical Imaging

# Prerequisites

- C/C++ Programming
- Linear Algebra
- Numerical Optimization
- CSCI 420 Recommended

# Administrative

#### When and where?

- Tuesday, Thursday, 11:00 am 12:20 pm
- KAP 158 (Kaprialian Hall)

#### Credits

• 3 Units

#### Website

• <u>http://cs599.hao-li.com/</u>

#### Exercises

#### **Programming assignments**

- based on OpenMesh (tutorial will be given Thursday next week)
- cover some core stages of the geometry processing pipeline
- C/C++ framework including 3D UI will be provided

#### Integral part of the lecture

• important for achieving course objectives

# Grading

#### **Exercises**

- Best 5 out of 6 exercises contribute to 70% of the final grade
- Each exercise counts 20 points
- Late submissions: every 5 minute removes 1 point in each exercise

#### Project

- Scope 2 months/person, Groups up to 2
- Implement a research paper around digital human capture but not limited to it
- Final presentation, code/documentation, contributes 30% of the final grade

# **Academic Integrity**

- Do not copy any parts of the assignments from anyone
- Do not look at other student's code
- Collaboration only for the project
- USC Office of Student Judicial Affairs and Community Standards (Hell) will be notified

# Course Objectives

- **Define** and **relate** the basic concept, tools, and algorithms in geometric modeling and digital geometry processing
- Critically analyze and assess current research on surface representations and geometric modeling and apply the proposed methods in your own work
- Design and implement individual components of geometric modeling system

#### Recommended Textbook

Botsch, Kobbelt, Pauly, Alliez, Levy: Polygon Mesh Processing, AK Peters, 2010



# Acknowledgement

#### **Course material taught at:**

- EPFL, Mark Pauly (My PhD Advisor)
- Bielefeld University, Mario Botsch
- INRIA, Pierre Alliez, Bruno Levy
- RWTH Aarchen, Leif Kobbelt



# An **Example**



# **Computer Graphics**



# **Performance Capture**



#### The Vision











#### **Facial Perfomance Capture**



#### **Geometry Capture**



#### **Realtime Facial Performance Capture**



# **Capturing Geometry**



#### Static 3D Capture





#### **Dynamic 3D Capture**





# **Commercial 3D Capture**

Artec Group



# **Full Body Capture**



#### **3D** scanner



#### 3D acquisition

#### **Multi-View Stereo**



Lee Perry-Smith, Infinite Realities + Agisoft

# **Capturing Cities**


# **Google Earth**





# Geometry γεωμετρία

geo = earth

metria = measure











# Geometry γεωμετρία











microscope



ultrasound



MRI scanner



x-ray diffractometer

# Geometry

γεωμετρία



stereo camera



radio telescope





time-of-flight scanner

# Overview

### **Geometric Modeling**

• Techniques and algorithms for representing and processing geometric objects

#### We will focus on *triangle meshes*

- main questions:
  - **why** are triangles suitable representations for geometry processing?
  - what are the central processing algorithms?
  - **how** can they implemented efficiently?

















# Cardiology



# **Evolutionary Biology**



# **Cancer Treatment**





# Digitized Future



## For Everyone



# For Everyone



## **For Everyone**



# Scanning@Home



## **Living Room Entertainment**



# In Tablet



# In Laptops



# In Laptops



# In Smartphones



# **From Capture to Fabrication**



3D printing



# Realtime Future



# Why Realtime?



#### VFX/Game Production



#### Robotics



#### Virtual Avatars



#### **AR/Virtual Mirror**

## **Realtime Game Engines**



# **Realtime Facial Animation**



## Virtual Reality **Reloaded**

Oculus VR 2012 / Crytek 2014



# Personalized Future



## 3D Self-Portraits



#### Omote3D Shashin Kan

# 3D Self-Portraits

#### Omote3D Shashin Kan



# 3D Self-Portraits



Omote3D Shashin Kan
#### 3D Self-Portraits



Omote3D Shashin Kan

### **3D Selfies**



#### **3D Selfies**



#### Personalized Games

USC/ICT

# 10X Speed UCapture/Process Time : 4 1

#### Personalized Applications

MPI IS, Embodee





entertainment

fitness

digital garment

#### **Fashion Industry**



#### Summary

#### **Geometry Processing**



#### **Classic Graphics**





#### **Modern Graphics/Vision**



#### The Future: Big Data / Robotics





#### Next Time

- Parametric Approximations
- Polygon Meshes
- Data Structures

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## Demos!

