Graphics, Vision and Video

Computer Vision for Computer Graphics

Prof. Dr. Christian Theobalt
James Tompkin
Summer Semester 2013
Coordinates

- MPI-INF – E1.4, room 019
- Tuesdays, 16:00-18:00 h
- Mailing List:
  - itvc@mpi-inf.mpg.de
  - https://lists.mpi-inf.mpg.de/listinfo
- Web Page:
  - gvv.mpi-inf.mpg.de/teaching/gvv_seminar_2013/
Organizers

- Christian Theobalt
  - MPI-INF, room 228.
  - theobalt@mpi-inf.mpg.de

- James Tompkin (contact for organizational issues)
  - MPI-INF, room 212.
  - jtompkin@mpi-inf.mpg.de
Formal Requirements in a Nutshell

- Presence is required!
  - We will monitor attendance.
- Read all papers.
- Submit questions for and participate in discussion.
- One topic is “Your Topic” (2 papers).
- Deliver a 50 minute presentation on your topic.
- Write a 6-8 page report on your topic.
- Grade: talk 40%, discussion 20%, report 40%.
Prior Knowledge

- Not for beginners in visual computing.

- Some experience through lectures / seminars in:
  - Computer vision,
  - Computer graphics,
  - Geometric modeling,
  - Basic numerical methods.

- Examples: You should know...
  - ...how a camera is mathematically modeled, ...how 3D transformations are described, ...how a system of equations is solved, ...
Organizational Issues

- Register by sending an email:
  - To jtompkin@mpi-inf.mpg.de.
  - Matriculation number, degree program, semester.
  - In case of overbooking: first come, first serve.

- Register in HiS POS system in 2/3 weeks (email to come).

- Topic assignment:
  - Send a list of 3 topics, with preference, by Thursday, April 18th.
  - We will try to accommodate wishes as much as possible.
  - We will give out assignments on Tuesday, April 23rd.
Organizational Issues

- 12 presentation slots in total:
  - First topic presentation: May 7th.
  - Each week thereafter.

- Topic supervisors:
  - One office hour per week (announced on seminar web page)
  - You can ask questions by e-mail any time.

- Topics will be covered in the order appearing on the seminar web page:
  - If necessary and mutually agreed upon, dates may be exchanged.
  - If you want to switch a slot, please talk to another participant if he or she wants to switch.
Presentations

- 50 minutes long:
  - ~5-10 minutes of summary of previous week, finding themes that join the two weeks.
  - ~40-45 minutes of presentation of two papers, again finding the common links between the papers.
- 5 minutes of direct public feedback from seminar organizers after talk.
Presentations

- Two scheduled meetings per topic:
  - 1st: 2/3 weeks prior to presentation:
    - Read papers for this meeting.
    - Ask questions if you have difficulties.
    - Discuss plans for presentation.
  - 2nd: 1 week prior to presentation:
    - Prepare a preliminary presentation.
    - We can provide feedback.

- It is your responsibility to arrange for the meetings with your supervisor!
Discussion

- 50 minutes long.
- Before seminar:
  - Submit 3 questions for discussion, 1 day before seminar, to jtompkin@mpi-inf.mpg.de. This is important. Your contribution here will be marked.
- At seminar:
  - One person chosen at random to lead discussion.
  - Receives digest of questions submitted before seminar.
  - Gives summary of the strengths and weaknesses.
  - Moderates and guides discussion.
  - Raises open questions that remain.
  - Integrates questions of participants.
Report

- 6 – 8 page summary of the major ideas in your topic.
- 3 – 4 additional paper references.
- 2 – 3 extra pages with your own ideas, e.g.,
  - Discuss limitations not mentioned in the paper and sketch a solution.
  - Try to suggest improvements.
  - Novel ideas based on content described in the papers.
  - Your ideas can be the result of the discussion after your presentation!

- The idea is that you get a feeling for your specific topic surpassing the level of simply understanding a paper.
Report

- Due date: **August 20\textsuperscript{th}, 2013** (4 weeks after last seminar).
- Send PDF by e-mail.
- We will provide a LaTeX-style on the seminar page.
- If you use other software, make it look like the LaTeX-example – your responsibility.
  - Strongly recommended to learn LaTeX.
Grading

- **Presentation**  (overall: 40%)
  - Form: time, speed, structure of slides. (30%)
  - Content: structure, story line & connection, main points, clarity (50%)
  - Questions: answers to questions. (20%)

- **Discussion**  (overall: 20%)
  - Submitted questions: insight, depth, inquisition. (33%)
  - Participation: willingness, debate, ideas. (33%)
  - Moderation: strengths and weaknesses, question integration (33%)

- **Report**  (overall: 40%)
  - Form: diligence, structure, appropriate length. (10%)
  - Big picture, topic in context. (20%)
  - Technical correctness. (30%)
  - Discussion / novelty / transfer / own ideas / ideas in own words. (40%)

CVfCG 2013 – First Meeting – 2013/04/16
Benefits

- Practice important skills in research:
  - Read and understand technical papers.
  - Present scientific results and convince other people.
  - Analyze and develop new ideas through discussions.

- Discussion is essential:
  - If you don’t participate, you miss a big chance.
  - Most ideas are developed in discussions about other papers.

  ➔ Prepare for the seminar classes!
  ➔ Benefit from the interaction in the group!
  ➔ Active participation!
What this seminar is not...

- A course to just sit and listen.
  - Come prepared.
  - Read all papers before class, think about problems, submit questions and discuss them in class.
  - Your participation benefits everyone – the group makes the seminar.

- “Cheap” 8 credit points
  - Don’t underestimate the time it takes to understand a paper, prepare a talk, and write a report.
  - Take it seriously!
Schedule

- First meeting, April 16th – Introduction. *You are here.*
- April 23rd – Lecture: “How to give a good talk”.
- May 7th – First presentation by a student.
- Thereafter weekly presentations – 12 slots.
Introduction to the Topics
Vision or Graphics?

CVfCG 2013 – First Meeting – 2013/04/16
Vision or Graphics?
Vision or Graphics?
Vision or Graphics?
Vision or Graphics?
Vision or Graphics?
Vision or Graphics?

Song Hye Kyo

CVfCG 2013 – First Meeting – 2013/04/16
Vision or Graphics?
Vision or Graphics?
Geometry

- Environment Models

[Bokeloh et al. EUROGRAPHICS 2009]
Appearance

- Human Performance Models:

  [Ma et al. EGSR 2007]
Motion

- Marker-based Performance Capture:
Computer Vision

- Low-level Vision:

  Feature detection

  Optical flow
Computer Vision

- High-level Vision:
  - Scene Understanding / Recognition / Reconstruction

Human motion estimation

Object recognition

Multi-view stereo reconstruction

CVfCG 2013 – First Meeting – 2013/04/16
Computer Graphics / Computer Vision

Real world

Images, videos, sensor data...

Virtual world

Images, videos...

Scene model:
- Geometry
- Material
  - Albedo
  - Reflectance
- Env. lighting
- Physics
  - Motion
  - Deformation

Computer Vision

Computer Graphics
Topics

- State-of-the-Art Research + Classic Papers
- Best Conferences and Journals in Computer Vision and Computer Graphics:
  - ACM SIGGRAPH
  - ACM SIGGRAPH Asia
  - EUROGRAPHICS
  - IEEE Intl. Conference on Computer Vision and Pattern Recognition (CVPR)
  - International Conference on Computer Vision (ICCV)
  - European Conference on Computer Vision (ECCV)
  - International Journal of Computer Vision (IJCV)
  - IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI)
Image-based: Illusion of Motion

- Kemelmacher-Shlizerman et al., Exploring Photobios, SIGGRAPH 2011
- Wu et al., Eulerian Video Magnification, SIGGRAPH 2012

Supervisor: James
Image-based: Patch Correspondence

- Barnes et al., PatchMatch: A Randomized Correspondence Algorithm for Structural Image Editing, SIGGRAPH 2009
- HaCohen et al., NRDC: Non-Rigid Dense Correspondence with Applications for Image Enhancement, SIGGRAPH 2011

Supervisor: James
Image-based: Super Resolution

- Tipping et al., [Bayesian Image Super-resolution](#), NIPS 2002
- Pickup et al., [Bayesian Methods for Image Super-resolution](#), The Computer Journal 2007

Supervisor: Kwang In Kim
Shape capture: Visual Hull Foundations

- Laurentini et al., *The Visual Hull Concept for Silhouette-Based Image Understanding*, PAMI 1994
- Cheung et al., *Visual Hull Alignment and Refinement Across Time: A 3D Reconstruction Algorithm Combining Shape-From-Silhouette with Stereo*, CVPR 2003

**Supervisor:** Kwang In Kim
Shape capture: Multi-view Stereo

- Goesele et al., Multi-View Stereo Revisited, CVPR 2006
- Valgaerts et al., Joint Estimation of Motion, Structure and Geometry from Stereo Sequences, ECCV 2010

Supervisor: Levi
- Goesele et al., Multi-View Stereo Revisited, CVPR 2006
- Valgaerts et al., Joint Estimation of Motion, Structure and Geometry from Stereo Sequences, ECCV 2010

Supervisor: Levi
Shape capture: Performance Capture

- de Aguiar et al., Performance Capture from Sparse Multi-view Video, SIGGRAPH 2008
- Gall et al., Motion Capture Using Joint Skeleton Tracking and Surface Estimation, CVPR 2009

Supervisor: Christian
Shape capture: Facial performance capture

- Beeler et al., High-Quality Passive Facial Performance Capture using Anchor Frames, SIGGRAPH 2011
- Valgaerts et al., Lightweight Binocular Facial Performance Capture under Uncontrolled Lighting, SIGGRAPH ASIA 2012

Supervisor: Levi
Shape capture: Facial performance capture

- Valgaerts et al., *Lightweight Binocular Facial Performance Capture under Uncontrolled Lighting*, SIGGRAPH ASIA 2012

Supervisor: Levi
Shape capture: Facial Performance Cap.

- Vlasic et al., *Face Transfer with Multilinear Models*, SIGGRAPH 2005
- Dale et al., *Video Face Replacement*, SIGGRAPH Asia 2011
Pose Estimation: Foundations

- Bregler and Malik, Tracking People with Twists and Exponential Maps, CVPR 1998
- Gall et al., Optimization and Filtering for Human Motion Capture - A Multi-layer Framework, IJCV 2008

Supervisor: Ahmed
Pose Estimation: Alternatives

- Stoll et al., Fast Articulated Motion Tracking using a Sums of Gaussians Body Model, ICCV 2011
- Shotton et al., Real-Time Human Pose Recognition in Parts from a Single Depth Image, CVPR 2011

Supervisor: Ahmed
Pose Estimation: Hands

- [Capturing Natural Hand Articulation](#), Wu et al., ICCV 2001
- [Motion Capture of Hands in Action using Discriminative Salient Points](#), Ballan et al., ECCV 2012

Supervisor: Srinath
Pose Estimation: Hands

- **Motion Capture of Hands in Action using Discriminative Salient Points**, Ballan et al., ECCV 2012

- Efficient model-based 3D tracking of hand articulations using Kinect, Oikonomidis et al., BMVC 2011

**Motion Capture of Hands in Action using Discriminative Salient Points**

Luca Ballan
Aparna Taneja
Jürgen Gall
Luc Van Gool
Marc Pollefeys

Efficient model–based 3D tracking of hand articulations using Kinect

Supervisor: Srinath
Illumination: Shape and Reflectance

- Joshi et al., Shape from Varying Illumination and Viewpoint, ICCV 2007
- Oxholm et al., Shape and Reflectance from Natural Illumination, ECCV 2012

Supervisor: Chenglei
Illumination: Decomposition

- Sunkavalli et al., Factored Time-Lapse Video, SIGGRAPH 2007
- Laffont et al., Coherent Intrinsic Images from Photo Collections, SIGGRAPH Asia 2012

Supervisor: Chenglei
Data-driven Dynamics: Models

- Anguelov et al., SCAPE: Shape completion and animation of people, SIGGRAPH 2005
- Guan et al., DRAPE: DRessing Any PErson, SIGGRAPH 2012

Supervisor: Helge
Data-driven Dynamics: Skin Deformation

- Park et al., *Capturing and Animating Skin Deformation in Human Motion*, SIGGRAPH 2006
- Neumann et al., *Capture and statistical modeling of arm-muscle deformations*, EG 2013

Supervisor: Christian
Data-driven Dynamics: Hidden spaces

- Safonova et al., *Synthesizing physically realistic human motion in low-dimensional, behavior-specific spaces*, SIGGRAPH 2004
- Akhter et al., *Trajectory Space: A Dual Representation for Nonrigid Structure from Motion*, PAMI 2011

Supervisor: Helge
Character/Motion Representations

1. Geometry based
   - e.g. Surface gradients

2. Learned Hidden Space
   - e.g. Temporal Basis
Applications: Advanced Video Editing

- Bhat et al., Using Photographs to Enhance Videos of a Static Scene, EGSR 2007
- Jain et al., MovieReshape: Tracking and Reshaping of Humans in Videos, SIGGRAPH Asia 2010

Supervisor: James
Applications: Advanced Video Editing

- MovieReshape

Example 2: "Basketball"
Monocular sequence
Summary

- Topic assignment:
  - Send a list of 3 topics, with preference, by Thursday, April 18th.
  - We will try to accommodate wishes as much as possible.
  - We will give out assignments on Tuesday, April 23rd.

- First topic presentation: May 7th

- Next week: “How to give a good talk”.

- Questions?
Final Example: The Foundry video