Seminar in Computer Graphics 186.175, WS 2023/24, 2.0h (3 ECTS)

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Important!

Register to course in TISS and TUWEL: to get news & updates

These slides will on TUWEL and institute website after this meeting

Official registration: by submitting the literature list

Topics are presented and chosen today, assigned tomorrow

Seminar Goals

Practice selecting, reading and understanding

- Search and select papers relevant to your topic
- Summarize them as a state-of-the-art report
- Prepare a talk about your topic in the seminar

This permits in-depth familiarization with the topic

More in-depth/spezialized than Bachelor seminar!

If well done → can continue to master thesis ...

Tasks

- Submit a literature list (chosen with supervisor)
- Attendance of 3 lectures
- Meetings with supervisor: paper selection, discussion of papers, preparing talk slides
- Alternative: evaluate and compare algorithms
- Write a report
- Review a report from a colleague
- Final talk in seminar

Literature List

- Analyze recent papers (select with supervisor)
- Study secondary literature to understand topic
- How to find relevant papers:
- SIGGRAPH Proceedings
- Google Scholar: find the right key words
- Survey papers, often-referenced papers
- Submits a list of 10+ papers to TUWEL → official registration

State-of-the-Art Report (STAR)

- 8 pages per student, must be in english
- Format in the style of a scientific paper
- Use LaTeX template on course website, can use Overleaf
- LaTeX tools and guides also on the website
- Submit the draft in PDF format
- Draft has to be complete and minimum 8 pages!

Scientific Review

- You will get a draft of another student to review
- Typical conference review form (Eurographics)
- This helps author to improve the manuscript
- Guides on review writing on course website
- You will receive 2 reviews (student, supervisor)
- Improve final report according to reviews

Seminar Talk

- Prepare slides in advance, using template
- Each student talks for 15 minutes, in english
- 5 minutes discussion after each talk
- Focus is on overview/comparison of methods
- Present so that other students will understand it
- Active discussion is mandatory and is graded
- Slides presentation from seminar PC (ODP, PPTX, PDF)

Grading

- Lecture attendance 5%
- Review: 15%
- Seminar slides+talk: 30%, discussion 5%
- Final report: 45%

- Late submission: 15% off task per day, so no points after 1 week (this also concerns the draft!)

Important Dates

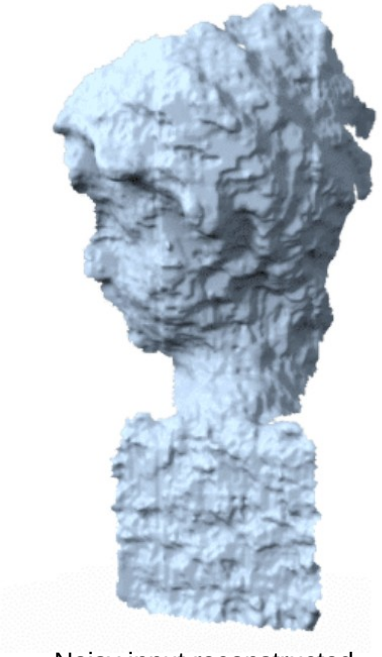
- 23.10. 23:59 Submit literature list (on TUWEL)
- 09.11. 13:00-15:00 Lecture Prof. Gröller
- 16.11. 13:00-15:00 Lecture Prof. Kaufmann
- 23.11. 13:00-15:00 Lecture Prof. Wimmer
- 18.12. 23:59 Submit report draft
- 08.01. 23:59 Submit review
- 23.01. 23:59 Submit slides
- 24.01. 09:00-13:00 Seminar talks
- 24.01. 23:59 Submit final report

Topic Presentation

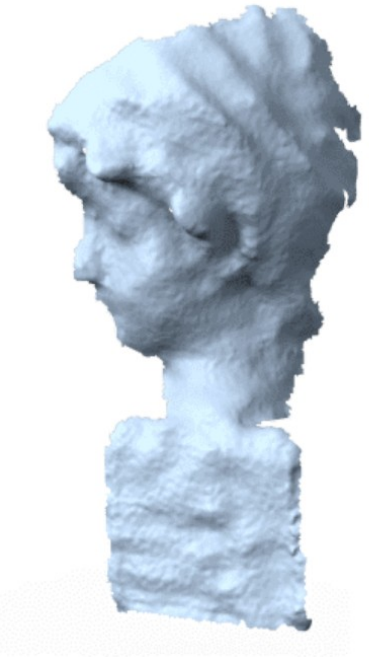
- Now 17 topics will be presented
- After the presentation, please mark down at least 3 in order of preference (1, 2, 3, …) and post your preferences in forum “Discussions” until the end of the day
- I will try to make a fair assignment of topics in case of conflicts and post them in forum “Announcements” tomorrow

1 Denoising Point Clouds

- Investigate denoising techniques for point clouds



Noisy input reconstructed with Poisson

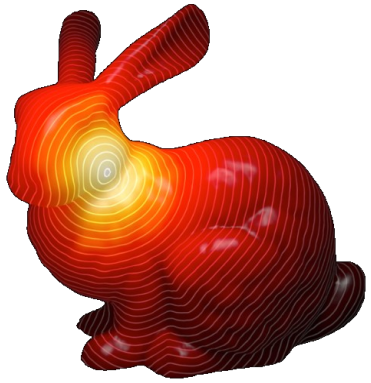


Denoised result reconstructed with Poisson

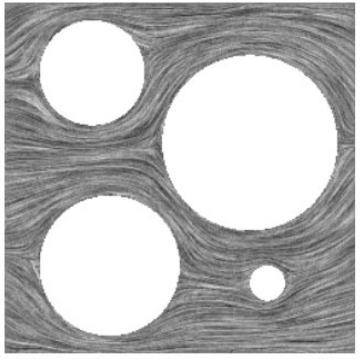
Ground truth surface

Rakotosaona, Marie-Julie & La Barbera, Vittorio & Guerrero, Paul & Mitra, Niloy & Ovsjanikov, Maks. (2019). PointCleanNet : Learning to Denoise and Remove Outliers from Dense Point Clouds: PointCleanNet. Computer Graphics Forum. 39. 10.1111/cgf.13753.

2 Solving PDEs with Monte-Carlo methods



$$\begin{aligned} \nabla \cdot (\alpha \nabla u) + \vec{\omega} \cdot \nabla u - \sigma u &= -f \quad \text{on } \Omega, \\ u &= g \quad \text{on } \partial\Omega. \end{aligned}$$



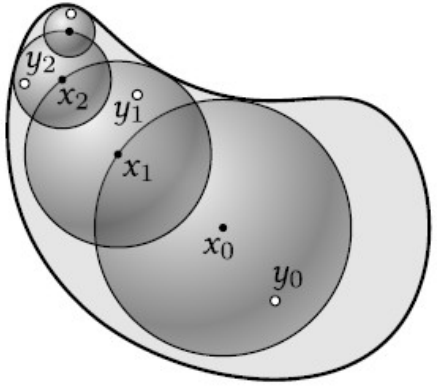


Fig. 5. A source term f can be approximated via a single random sample y_i at each step.

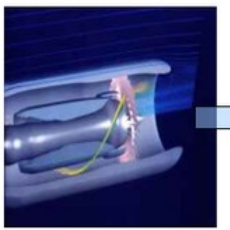
Rohan Sawhney and Keenan Crane. 2020. Monte Carlo Geometry Processing: A Grid-Free Approach to PDE-Based Methods on Volumetric Domains. *Proc. SIGGRAPH* 39, 4 (2020).

Rohan Sawhney, Bailey Miller, Ioannis Gkioulekas, and Keenan Crane. 2023. Walk on Stars: A Grid-Free Monte Carlo Method for PDEs with Neumann Boundary Conditions. *ACM Trans. Graph.* 42, 4, Article 1 (August 2023),

Ryusuke Sugimoto, Terry Chen, Yiti Jiang, Christopher Batty, and Toshiya Hachisuka. 2023. A Practical Walk-on-Boundary Method for Boundary Value Problems. *ACM Trans. Graph.* 42, 4 (August 2023), 16 pages. https://doi.org/10.1145/3592109

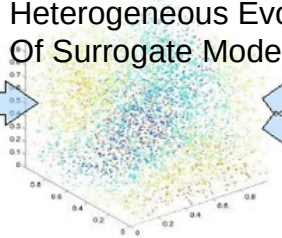
3 Surrogate-based optimization and learning

- (Lighting) Design optimization
- Expensive (differentiable) simulations
- Fit an inexpensive model
- Speed up design process
- Allow interactive editing

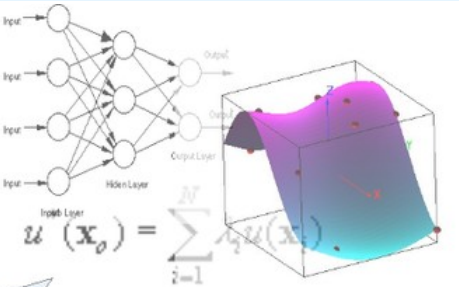


Expensive Simulation Code

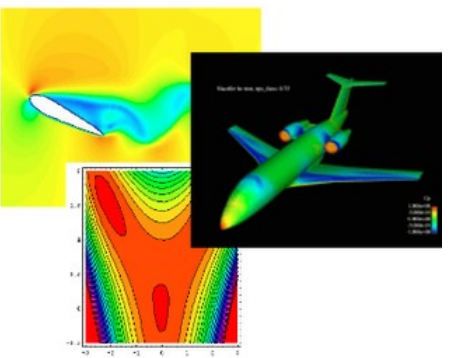
Gorissen, 2022, Heterogeneous Evolution Of Surrogate Models.



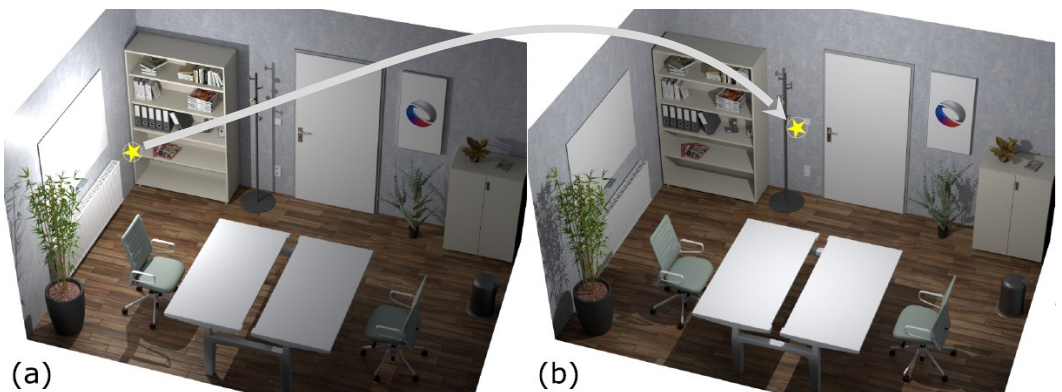
Design Space



Cheap, Global Metamodel



Design Optimization

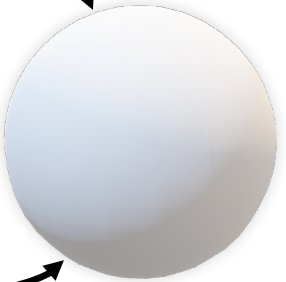


(a) (b)

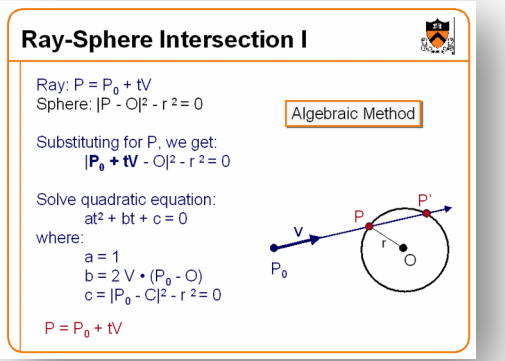
4 Rendering of Implicit and Parametric Functions

- Some shapes can be described...
  - in parametric form, e.g. $[u, v] \rightarrow [x, y, z]$
  - in implicit form, e.g. $F(x, y, z) = c$
- Which shapes are possible?
- How to render parametrically described shapes?
- How to render implicitly described shapes?
  - e.g. Signed Distance Fields
- Properties, Restrictions?
- Possible applications and usage scenarios?
- Rendering performance?
- State of the art? Latest advances?

Parametric Form:

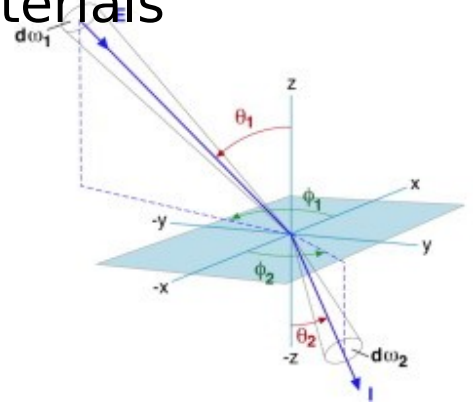


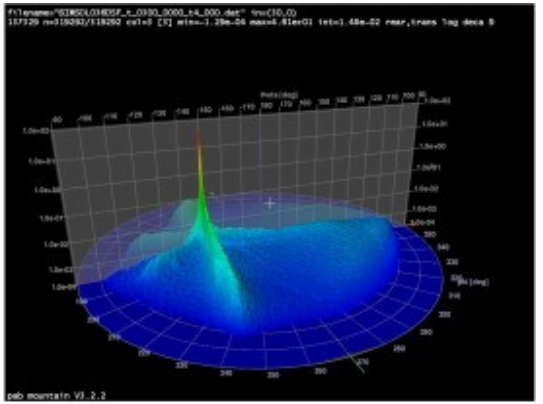
Implicit Form:



E.g.: intersect implicitly described spheres

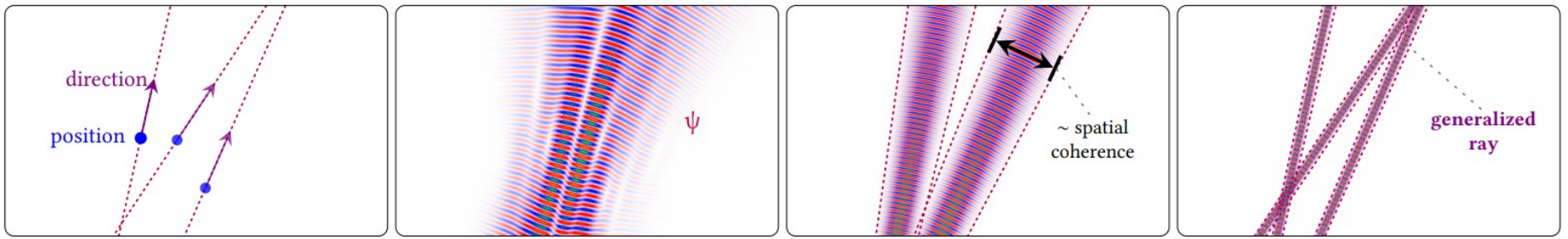
Conduct a survey of recent advances in the representation and application of measured materials





6 Wave-Optics Rendering

- What is it all about...
  - Difference to regular ray optics



A Generalized Ray Formulation For Wave-Optics Rendering. Steinberg et al. 2023

7 Real-time Weather Systems

https://www.guerrilla-games.com/read/the-real-time-volumetric-cloudscapes-of-horizon-zero-dawn

Clouds/
Atmosphere

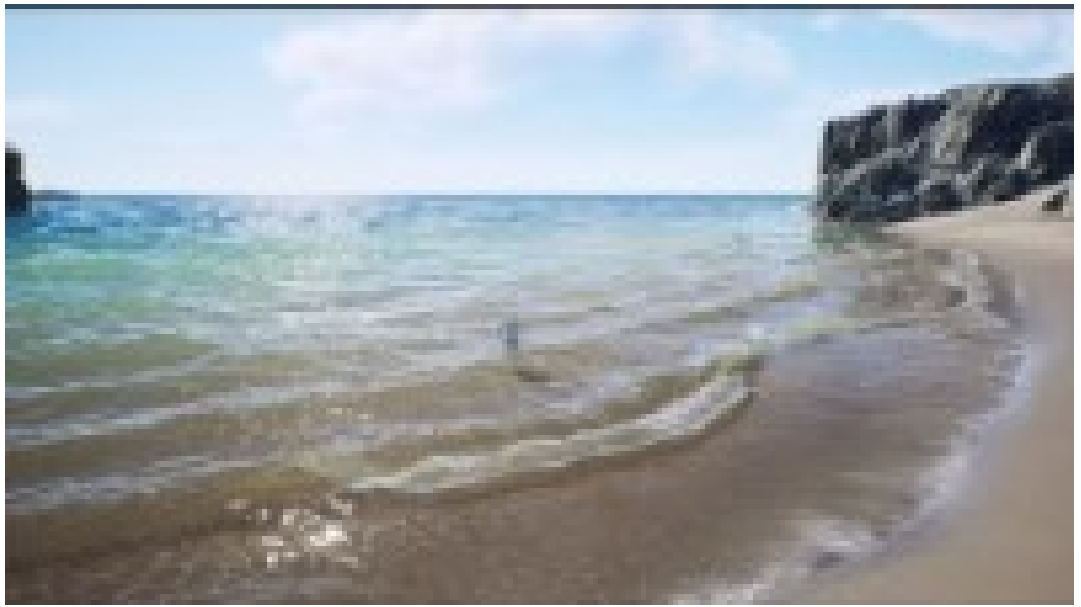
Emission:
Northern Lights/
Lightning

Particles: Snow/Rain

https://www.youtube.com/watch?v=d61_o4CGQd8

Wind

8 Towards Real-time Fluid Simulations



Fluid Flux 2.0 – UE5

Ocean Simulation using FFT

https://dl.acm.org/doi/
10.1145/2791261.2791267

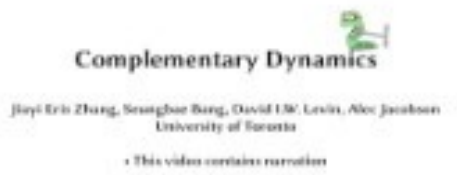
9 Physically based Character Animation

Inverse Kinematics

https://www.youtube.com/
watch?v=sVntwsrjNe4

Learning-based approaches

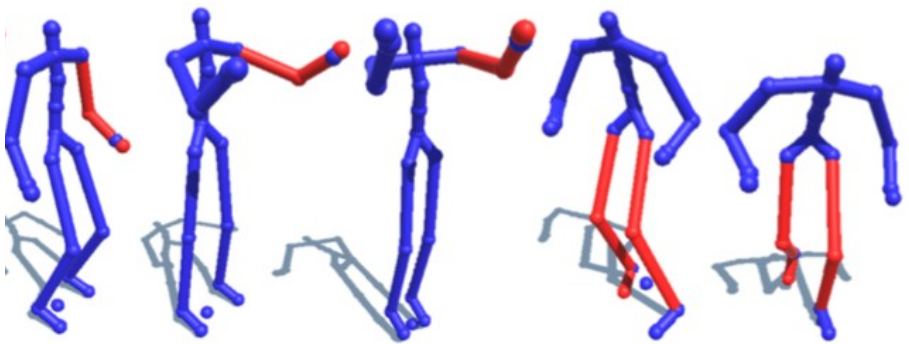
https://github.com/
sebastianstarke/AI4Animation

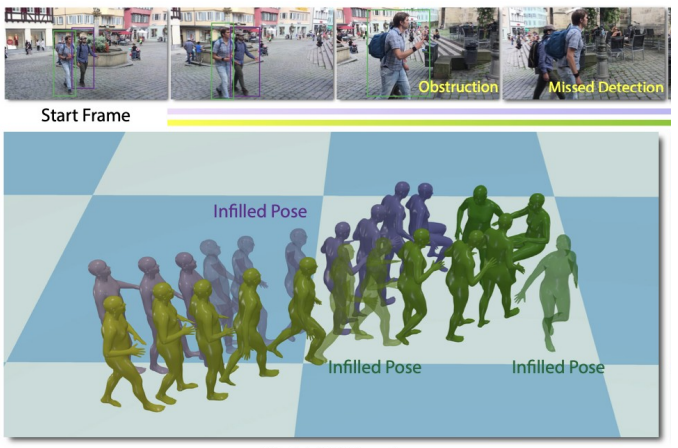


Complementary Dynamics

https://www.dgp.toronto.edu/projects/
complementary-dynamics/

10 Human Motion Synthesis Based on Partial Specification

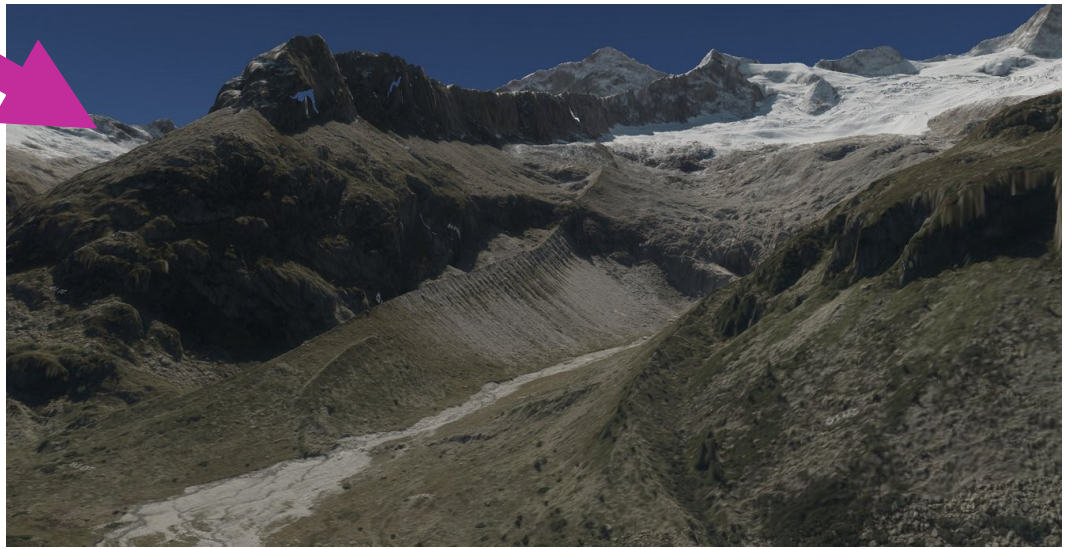




Kaufmann, Manuel, et al. "Convolutional autoencoders for human motion infilling." *2020 International Conference on 3D Vision (3DV)*. IEEE, 2020.

Yuan, Ye, et al. "GLAMR: Global occlusion-aware human mesh recovery with dynamic cameras." *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*. 2022.

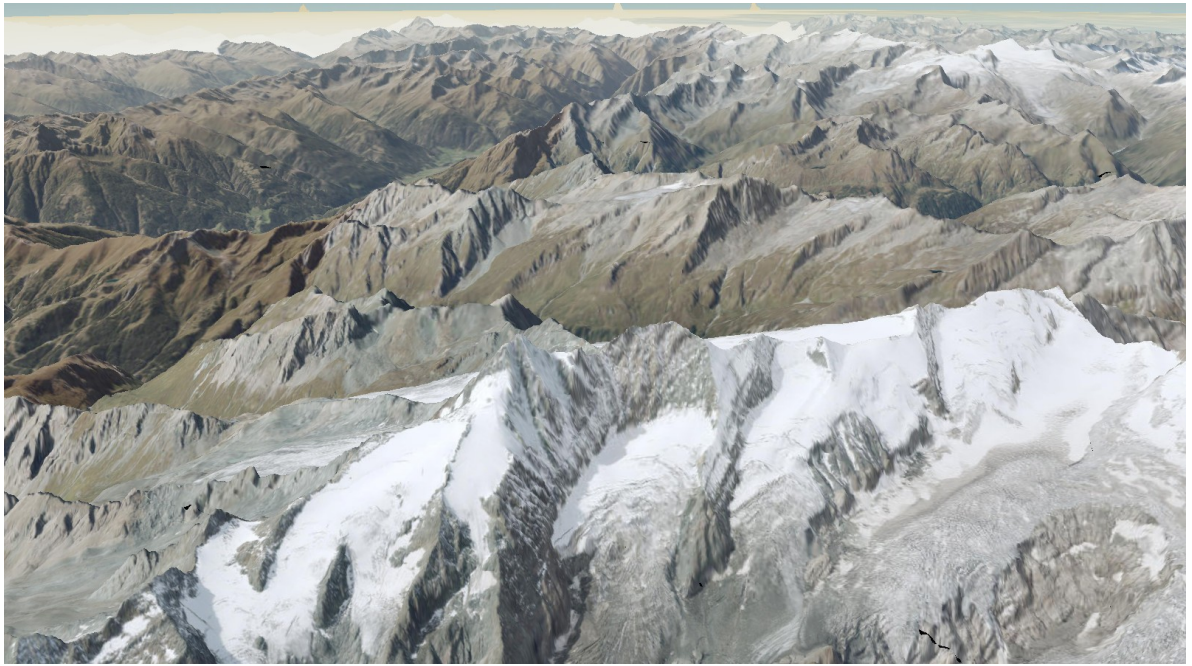
11 Mesh improvements using photos



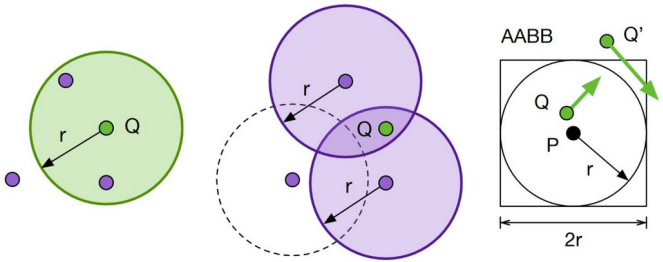
(own work)

12 Terrain Rendering Systems

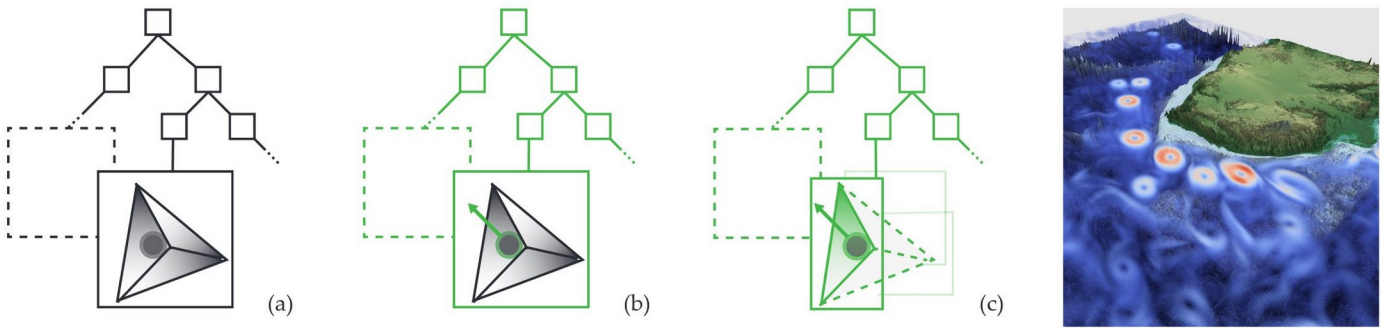
- 2.5D and 3D Terrain rendering
- Level of Detail (LoD)
- Planetary scale



- Investigate different use-cases for hardware RT



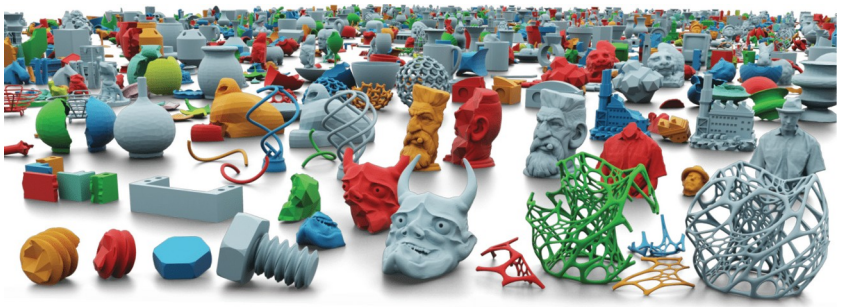
Zhu. "RTNN: Accelerating Neighbor Search Using Hardware Ray Tracing." *PPoPP '22*. ACM, 2022.



Wald et al. "RTX Beyond Ray Tracing: Exploring the Use of Hardware Ray Tracing Cores for Tet-Mesh Point Location." *HPG '19*. Eurographics Association, 2022.

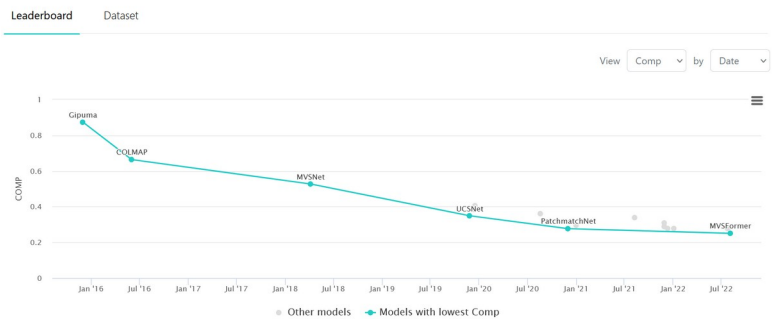
14 Datasets for Deep Learning

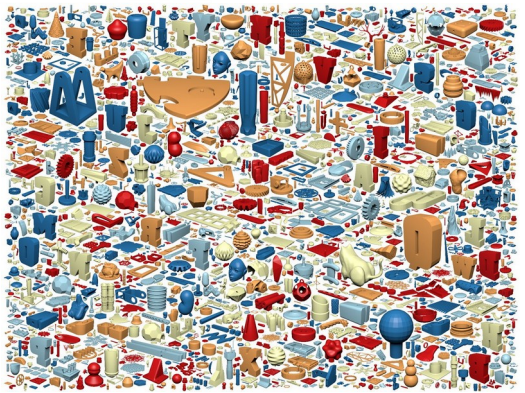
- Focus on 3D Reconstruction
- Sizes, Properties, Benchmarks



3D Reconstruction on DTU

Leaderboard Dataset

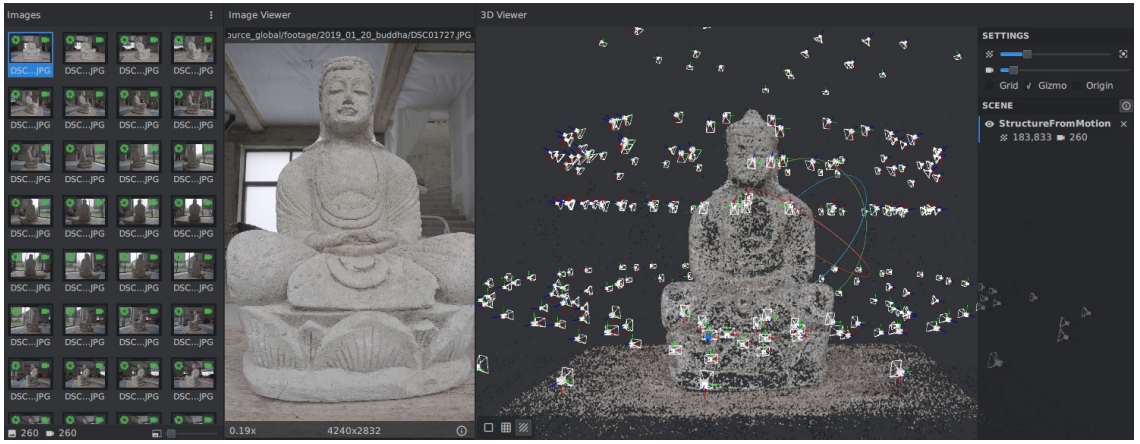


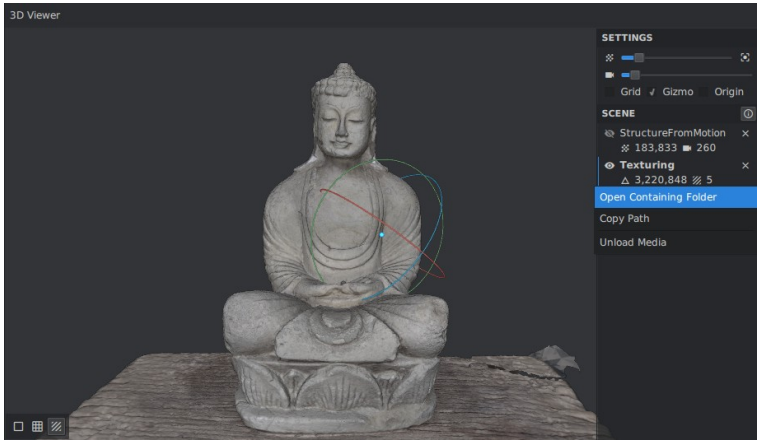


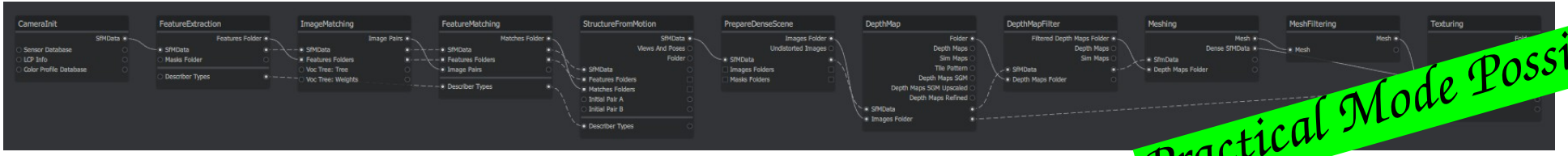
https://paperswithcode.com/sota/3d-reconstruction-on-dtu

Philipp Erler

15 Photogrammetry: Algorithms of AliceVision







Practical Mode Possible!

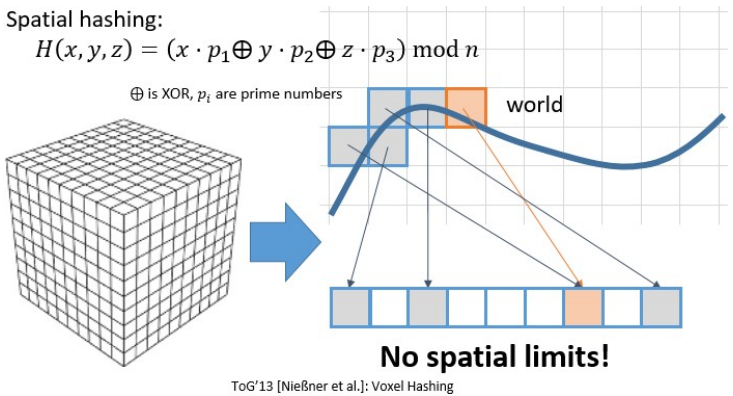
Photogrammetry: turn photos into a colored 3d model
Theory: Describe the algorithms used in AliceVision (Meshroom default pipeline) and find weak spots
Practical: Explain the influence of the many parameters and find a good setup for our test data

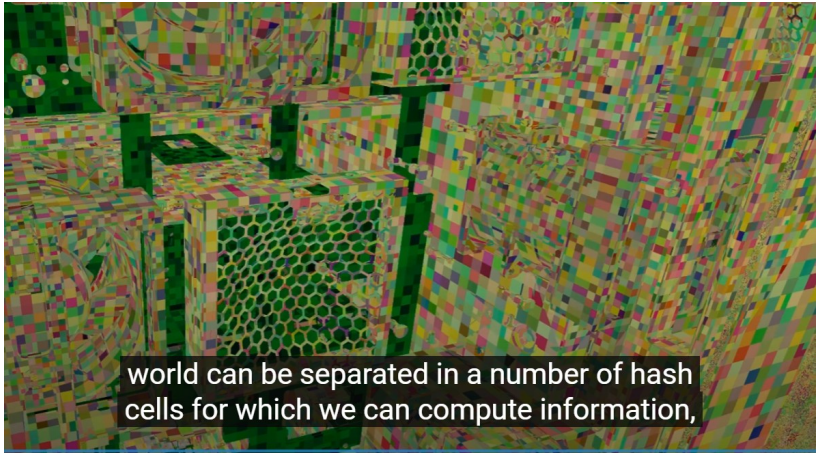
https://sketchfab.com/blogs/community/tutorial-meshroom-for-beginners
https://alicevision.org/#meshroom

Philipp Erler

16 Spatial Hashing

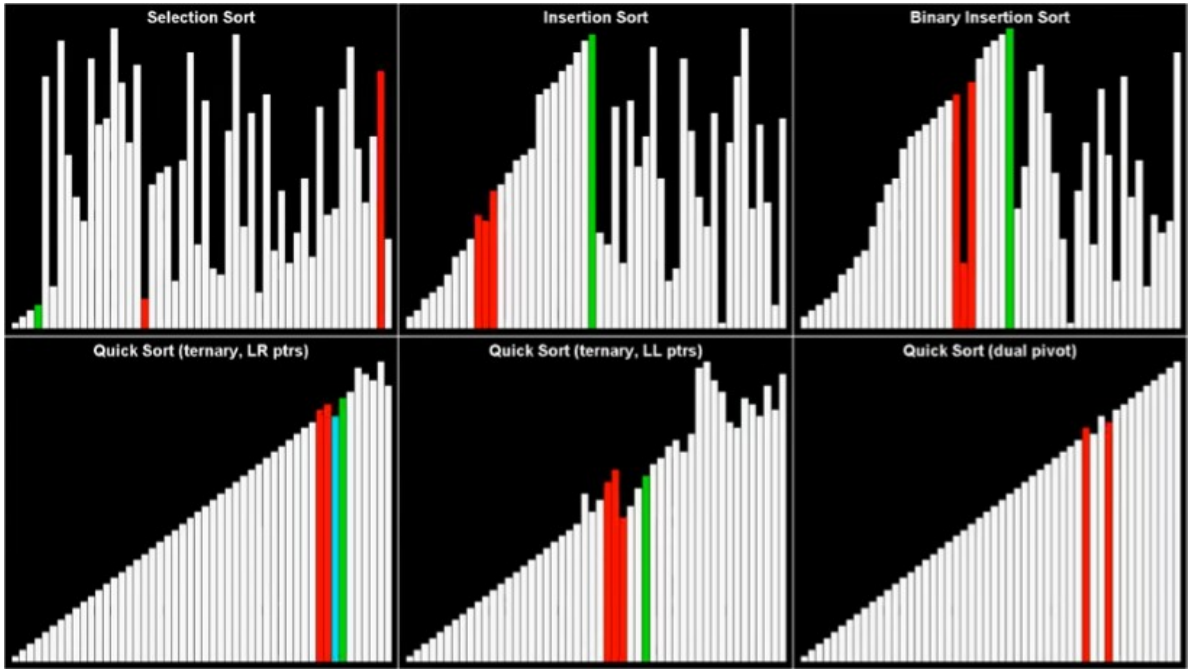
- Space Partitioning with hash maps
  - Huge (“infinite”?) “sparse grid” instead of quadtree, octree, ...
- Hash map entries for occupied space (cells)
- O(n) lookup of geometry around given world coordinate
- Investigate algorithms, use cases, etc.





17 Sorting on the GPU

- Overview over various sort algorithms
- Advantages, Limitations, Performance, ...



https://www.youtube.com/watch?v=BeoCbJPuvSE

Topic Assignment

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- I will try to make a fair assignment of topics and post them in forum “Announcements” tomorrow

Questions?

- Get in contact with your supervisor ASAP
- Discuss literature list with your supervisor
- Submit the list to TUWEL by 23.10.