Perceptually Driven Point Sample Rendering

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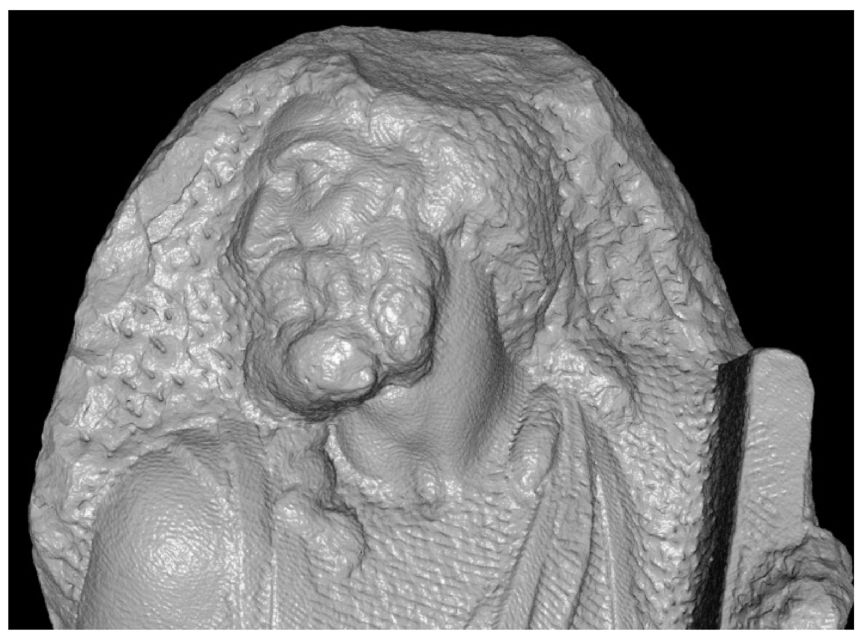
Abstract

Our work focuses on the selection of level-of-detail (LOD) in the context of point sample rendering system. The computational model of the human visual system (HVS) is used to find those features of the geometry, whose visual difference from the fully refined geometry is highest. Those features are refined preferably.

The main problem is the computational cost of the model of HVS, which preclude its use in interactive application, whereas the point sample rendering is intended for interactivity. Thus a preprocessing is carried out, where the perceptual characteristics of the model are found and stored with the model description. During rendering, the precomputed data are used to select appropriate LOD for given viewing conditions.

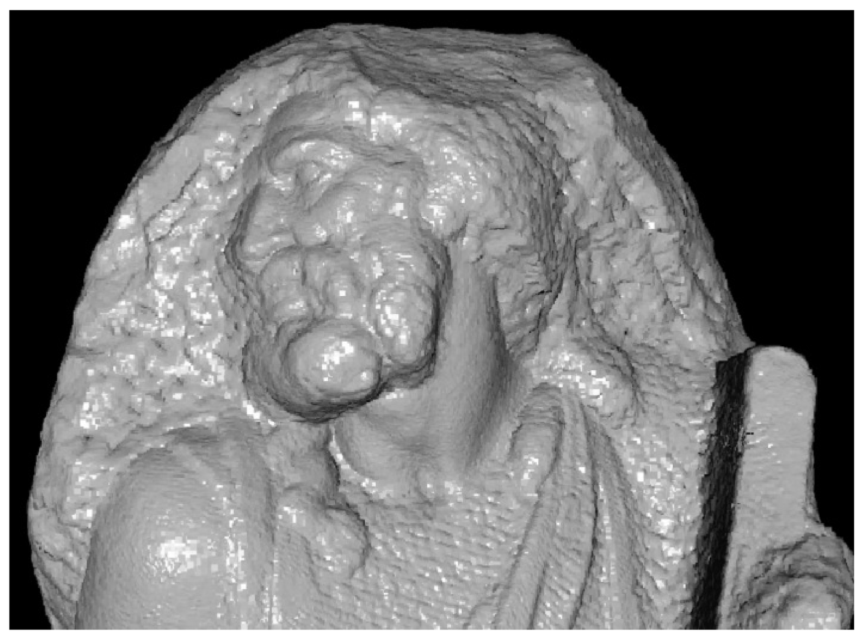
1. Point Sample Rendering and LOD

- Assumptions
  - Object modeled by a huge number of unconnected points
- Example: QSplat [1]
  - Preprocess
    - Each point is represented by a small sphere
    - Hierarchy of spheres is built
  - Rendering
    - LOD is dynamically selected for each frame by traversing the hierarchyt
    - The spheres, whose projected radius is smaller than given threshold, are splatted to the screen



A):14,835,967 splats , 8308 ms (Fully refined)

B): 1,017,149 splats , 722 ms

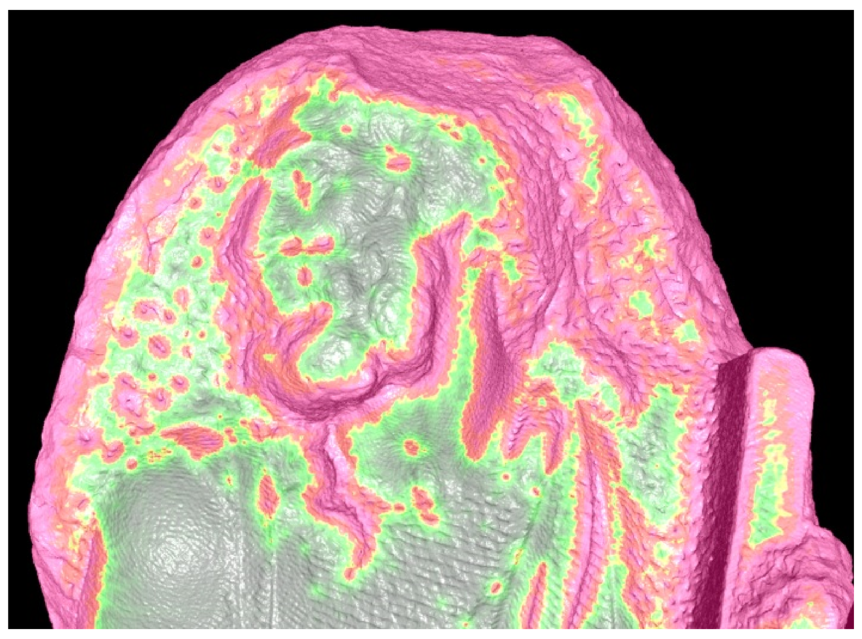


C):259,975 splats , 215 ms

D):130,712 splats , 132 ms

2. Perceptually Driven LOD Selection

- Motivation
  - Visible difference between renderings from refined geometry and coarser geometry is not constant over the image plane (see figure below)
  - The computational effort for refining should be aimed to the features, which cause highest difference
- Problem
  - Evaluation of visible differences is too expensive to be done in realtime
- Our strategy
  - Perceptual analysis is done as a *preprocess*
  - Results are stored with the model
  - During *rendering*, those data are used to control the refinement



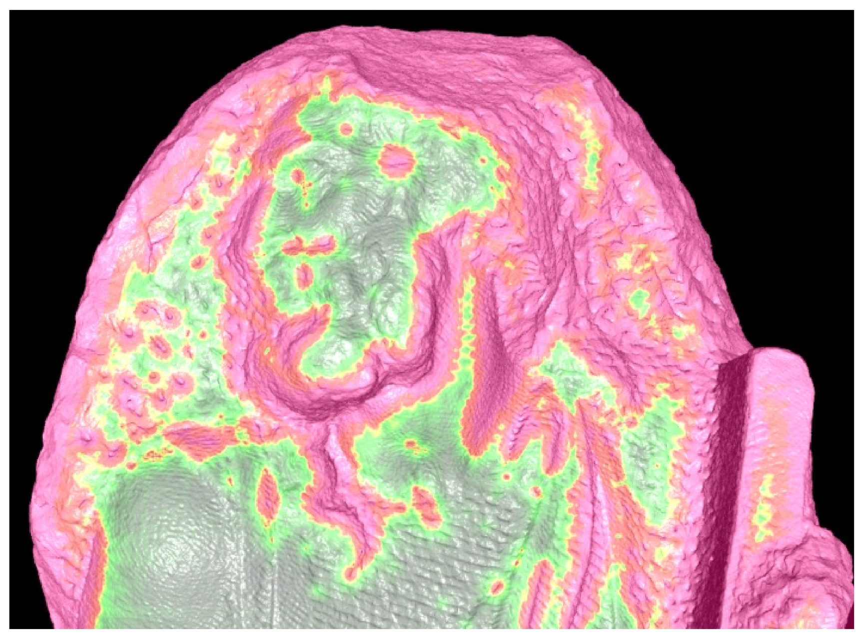
VDP(*A*, *B*)

3. Preprocessing Stage

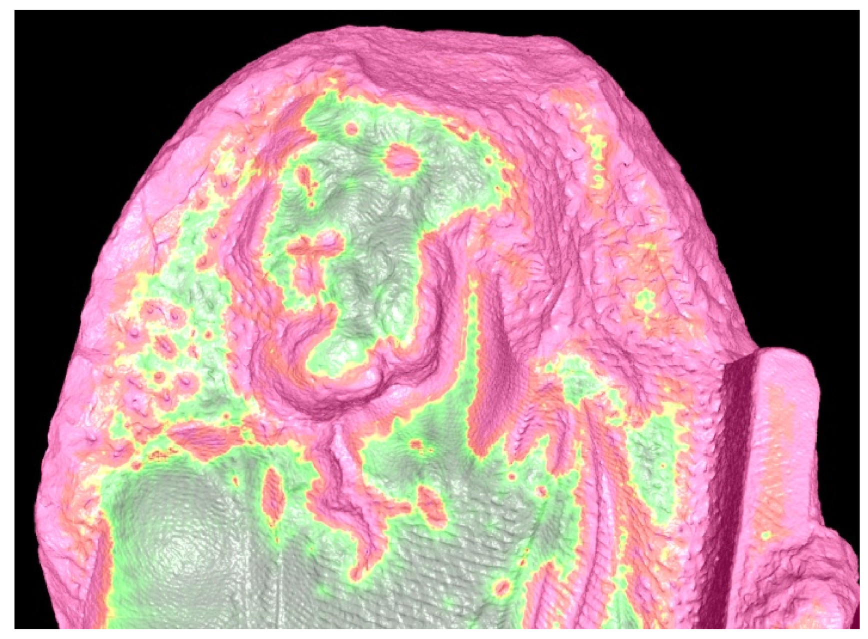
- Select viewing position and direction
- Select shading model and light position
- Render the model using fully refined geometry, result is image *I*
- Render the model using lower level of detail *L*, result is image I_L
- Run Visual Difference Predictor VDP(I,I_L) to get visible difference image (see figures)
- Identify the features of the geometry, which are projected to the image, and assign to them a coefficient corresponding to their visible difference from the refined image
- Encode the coefficients with the model
- Repeat for different levels of details, shading models, light positions and viewing parameters

4. Possible Pitfalls of Perception Preprocessing

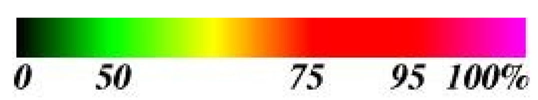
- Visual difference between two levels of detail is dependent on many parameters:
  - *viewing position*
  - *viewing distance*
  - adaptation luminance
  - rendering technique
  - lighting model
  - light direction and parameters
  - …
- Questions to be answered in our work:
  - Are the visible differences between different levels of detail at least approximately consistent when those parameters change?
  - Can the perceptual importance of different parts of the geometry be assessed using a small set of images taken from different viewpoints?



VDP(*A*, C)



VDP(*A*, D)



Probability of discrimination

5. Conclusions

We proposed a novel way of driving the level of detail selection in point sample renderer. Using our approach, the computational effort for refining the geometry representation is aimed to those features, which cause the highest difference with respect to the fully refined geometry. We believe that our system will prove its usefulness after testing the prototype implementation.

6. References

[1] Rusinkiewitz, S. & Levoy, M.: Qsplat: A Multiresolution Point Rendering System for Large Meshes. Proceedings of SIGGRAPH 2000, pp. 343-352.