Questionnaire SciVis SS2020

Last update on 06.07.2020

Stereo

Depth Perception

1. Given some example images, explain the contained perceptual depth cues?
2. Give examples of dynamic depth cues and explain these!
3. Explain the terms accommodation and vergence as well as conflicts between them!
4. Draw an example pair of images that lead to retinal rivality, explain the effect and give a real world example where this effect leads to a stereo frame violation.
5. Explain a plot of the Panum's fusional area!
6. Explain binocular disparity, and compare it to the term parallax!
7. What is a perceptual model and how can it be exploited in scientific visualization?
8. What is the disparity sensitivity function and how can it be measured in a use study?
9. What are the two main parameters on which the disparity sensitivity depends?
10. Given a sample anaglyph image, point out regions where depth perception is most effective!
11. Explain the term "Backward-Compatible Stereo" and how one can generate backward-compatible anaglyph images.
12. Explain the effect of "Shadow Stereopsis"! Can you imagine an application that exploits this effect?
13. Explain the deadeye effect and give examples of its usage in visualization!

Display Technology

14. Explain the difference between the 3D Formats FHD3D, Side-by-Side and Top-and-Bottom
15. Explain the different multiplexing techniques to show stereoscopic content!
16. Compare advantages and disadvantages of anaglyph versus infitec technology!
17. How can one support multiple users?
18. Sketch a situation that leads to stereo frame violation!
19. Why is stereo on stereo displays more exhausting than in the real world?
20. What are the most important parameters to compare HMDs?
21. Give some examples of multiwall stereoscopic setups!
22. Compare fishtank, HMD and projection-based stereo with respect to immersion, resolution and cost/nursing?

Stereo Rendering

23. Given a figure with the OpenGL transformation pipeline, explain which transformations need to be specialized per eye during stereoscopic rendering!
24. Explain negative and positive parallax with a sketch!
25. Sketch the parallax over depth in a function plot and explain the most important properties of the function plot!
26. Explain the problem of depth aliasing and how to overcome this!

27. Explain with a sketch how the stereo frustum transformations can be decomposed into a standard frustum operation, a shearing and a translation!
28. Given a rendering of cyclopic vs per eye lighting, explain which rendering corresponds to which lighting scheme! Discuss advantage and disadvantage of both lighting schemes! Explain how they differ in their implementation!
29. Given an anaglyph rendering, determine which filter color to be used for left and right eye! Show the parallax zero plane in the rendering!
30. What is the pupillary distance? What is the average value for humans and how can you measure it in reality and in case you use an anaglyph stereo viewer on a monitor?
31. How do you construct the frustum for each eye when rendering stereo on a display wall with the user in an arbitrary location and orientation to the display wall?

Stereo Rendering Process

32. Compare indirect and direct stereo rendering and discuss advantages of each approach!
33. In indirect mode, how can one access the information in the rendered framebuffer of the other eye? How can one check whether the surface point seen from the current eye is visible in the other eye?
34. Explain why single pass stereo rendering can increase performance!
35. How can single pass stereo rendering be implemented?

Stereo Rendering Guidelines

36. How do you place a scene optimally in front of a display wall?
37. What do you have to take care of when allowing the user to move objects?

Particles

Particle Data

1. Give examples of particle datasets!
2. What are the most important particle attributes?
3. How can you represent the orientation of particles?
4. How can one represent orientation and non-uniform scale of a particle compactly?

Shader Based Raycasting

5. What is the problem with tessellation and billboarding of particles in the case of large datasets?
6. Explain the idea of particle raycasting and how this can be integrated into the rendering pipeline!
7. Suppose you have a solution of sphere raycasting, how can you extend it to ellipsoids?
8. What is the principle approach to correct the fragment depth in particle raycasting?
9. What is the early depth test and how can one exploit it in particle raycasting?
10. How can be union and intersection operations of primitives be handled correctly in raycasting, when one has a way to compute intersections with the combined primitives?
11. How can you efficiently transform a particle oriented bounding box efficiently into eye and clip space?
12. Explain a simple approach to raycast a cylinder based on the tessellation of its bounding box!

13. Explain different approaches to size an arrow based on the length of a to be visualized vector valued attribute! Discuss advantages of the different methods!
14. Explain the interpolation problem one gets when tessellating the tip of an arrow or a cone and explain how to resolve it!

Tube Based Visualization

15. How can one interpolate a tube between two discrete sample points smoothly?
16. In case of particles with orientation, how would you interpolate the orientation attribute?
17. When rendering tubes with thick lines, explain a strategy to interpolate colors and sketch an example with an acute angle!
18. What is a generalized cylinder and how can one tessellate it?
19. What is the relative curvature condition and how can one avoid artefacts, in cases where it is violated?
20. What are hyperstream-lines?
21. Can any ribbon in 3D be oriented everywhere orthogonally to the viewer?

Large Particle Data

22. In which case do we need to visibility sort particles for rendering?
23. What parallel sorting algorithm performs good for particle datasets? Explain the proposed sorting algorithm on a simple example!
24. How can you avoid aliasing in the illumination in large particle datasets with deferred shading?
25. Explain occlusion culling with Hardware Occlusion Culling and compare it to the use of a hierarchical z-buffer! Explain how to exploit both approaches during particle rendering!

Derived Surfaces

26. What are metaballs and how can the corresponding surfaces be rendered efficiently?
27. Explain the different surfaces used to visualize molecular surfaces and how to compute them!
28. In which cases is it important to construct the surfaces directly on the GPU?
29. Given an image of a Solvent Excluded Surface explain how the different patch types are created!

Terrain

Data Sources

1. What is a DEM and how is it typically stored?
2. Compare the regular grid representation of a DEM with a TIN representation!
3. What is an adaptive tessellation approach and why is this needed in terrain visualization?
4. Explain the classification of Geo Visualization techniques based on the dimension of the visualized reference and attribute spaces and give examples!
5. How can one vary between focus and context in terrain visualization independently for the terrain and the visualized data and its uncertainty?

Data Structures

6. Explain how to store a complete binary tree without explicitly storing pointers to child nodes! How can one store two binary trees without child pointers in an interwoven fashion?
7. What is a right triangle hierarchy?
8. Explain the term front and valid front!
9. Why do we need to avoid T-vertices in terrain rendering even if we place the T-vertex on the incident edge?
10. Specify conditions for a valid triangulation extracted from a HRT.
11. What is a diamond and how can we use it in adaptation of a valid front inside a HRT?
12. Rendering
13. Enumerate typical refinement criteria to steer view-dependent terrain adaptation!
14. What do we gain from the use of a priority instead of a binary refinement predicate?
15. Compare Top Down and Incremental refinement strategies and explain why most often only the top down approach is used!
16. Explain the given pseudo code of a top down refinement implementation based on a force_split method!
17. What is a diamond monotonous refinement criterion and what does it help in the implementation of a refinement algorithm?
18. What is the difference between the Hausdorff-distance and the height difference when computing an object space error?
19. How can one ensure that object space errors are nested?
20. What is the basic idea to convert an object space error to a screen space error based on the camera parameters?
21. In which cases does the use of an anistropic error help to save triangles?
22. Why is the use of nested spheres for the refinement criterion not very efficient?

Implementation

23. Explain on an example of a HRT how one can extract a triangle strip recursively (for the simpler non-adaptive case)!
24. Why is the per triangle based refinement of a HRT not very efficient?

Batched Methods

25. Explain the basic principle to use the adaptive refinement of a HRT for batch based refinement!
26. Name further advantages for the use of a batched HRT approach!
27. Explain the basic principle of geometry clipmaps!

Shading

28. How can one compute the surface normal from the height values?
29. Explain the idea of ambient occlusion and at least two variations of the lighting model!
30. Explain how one can illustrate the effect of a moving sun with ambient aperture lighting!

Volume

Data Sources

1. Name some data sources for volumetric data!
2. Discuss advantages and disadvantages of different grid types!

Reconstruction

3. Explain linear and multi-linear interpolation!
4. Given an image of iso-surfaces generated from different volume reconstructions, argue on the reconstruction techniques used!
5. How can one interpret the reconstruction on a regular grid as a convolution?
6. What properties should a reconstruction filter fulfill?
7. Explain how to implement cubic interpolation with a convolution filter in the 1D case!
8. How can one evaluate the quality of a cubic reconstruction filter? What artefacts can arise?
9. How can one generalize a 1D filter to 2D and 3D?
10. How can the multi-linear texture lookup efficiently implemented on GPUs be exploited for fast cubic interpolation?

Tetrahedral Meshes

11. Explain how barycentric interpolation works!
12. Explain how the half-face data structure stores adjacency information!
13. How can one efficiently solve the point location problem on a tetmesh?
14. How can one fake smooth gradients on a tetrahedral mesh to improve smoothness of lighting?
15. Given an image of lighted iso-surfaces with normals computed according to different normal computation schemes on a regular grid, argue on which method was used for which image!

Slicing

16. Explain the different slicing techniques!
17. How can one render the an oblique slice through a volume?
18. Contouring
19. Explain the contouring methods according to Cuberille, Marching Cubes and Marching Tetrahedra!
20. Direct Volume Rendering
21. Name different compositing strategies!
22. What is the advantage of the blending operator for compositing compared to averaging or maximum intensity projection?
23. Explain the given formula of the volume rendering integral!
24. In which cases can the volume integral be solved analytically?
25. Why is it important to scale the emission values with the absorption probabilities?
26. Is the volume rendering integral scale invariant? How to deal with this?

Transfer Function Design

27. Explain Hounsfield units!

28. Why is a 1D transfer function typically not sufficient?
29. Explain the idea of design galleries for the design of transfer functions!
30. Explain how one can use pre-integration to support larger integration step sizes with the same image quality!
31. How can one efficiently re-compute the pre-integration table when the user changes the transfer function?
32. What secondary attributes can be used for multi-dimensional transfer functions?
33. Explain on a sample scatter plot of the scalar value and the gradient strength what the arc shaped high density regions correspond to!
34. What is a fiber surface?
35. Why is the visualization of a histogram essential during transfer function design?
36. What is a continuous histogram and a continuous scatter plot?
37. What are advantages for the continuous versions?
38. How does the interpolation scheme influence the correct rendering of a continuous scatterplot?

Rendering Algorithms

39. Explain the basic principle of GPU based volume raycasting!
40. How can one incorporate opaque objects in GPU based volume raycasting?
41. Explain different implementations of empty space skipping and step size adaptation techniques!
42. How can one do a visibility sorting of tetrahedral in a tetrahedral mesh?
43. How is a tetrahedron rendered in the projected tetrahedral rendering approach?

Topology (not content of exam)

Topological Structures

1. Given an image of the contour plot of a height field, mark the critical points and determine their types!
2. Explain the concept of a Reeb Graph and a contour tree and find their edges in the example!
3. Explain the concept of a filtration!
4. What are stable and unstable manifolds and how can one compute the Morse-Smale complex from these?
5. How can one exploit the Contour Tree during transfer function design?
6. Explain the quadrangle lemma on an image of a Morse-Smale complex!
7. Piecewise Linear Manifolds
8. In a 2D example find the star and the link of a vertex and an edge!
9. When is a piecewise linear manifold simply connected?
10. Explain the meaning of the Betti numbers for piecewise linear 3-manifolds!
11. What does the barycentric interpolation imply on isosurfaces and integral lines within a tetrahedron?
12. What is the index of a critical point and what is the multiplicity? How can index and multiplicity be computed on a PL manifold?
13. How can one deal with multi-saddles?

Persistence

14. Explain the concept of a persistence diagram on the image of an example and discuss the Elder's rule!
15. What is a persistence curve and how can one exploit it to define a persistence threshold?
16. Reeb Graph
17. Explain how one can decompose the scalar function defined over PL manifold into a mapping to the Reeb Graph followed by a mapping to the scalar values!
18. What does a vertex and an edge of the Reeb Graph correspond to on the PL manifold?
19. How does the number of loops in the Reeb Graph relate to the number of handles of a 2-mannifold?
20. How can one segment a PL manifold with the help of the Reeb Graph?

Algorithms

21. How can one efficiently compute a join tree of a PL manifold?
22. Explain the global strategy to efficiently compute a contour tree of a PL manifold in any dimension!
23. What is the general concept of computing a contour tree from a split and a merge tree?
24. The continuity of a PL manifold is not sufficient to define a continuous Morse-Smale complex. How is this reflected in the integral lines?
25. How can the simulation of differentiability resolve the problems with merging and splitting integral lines?
26. What is a Quasi Morse-Smale complex?
27. Sketch an algorithm to compute a Quasi Morse-Smale complex on a PL 2-manifold!

Simplification

28. How can one use persistence analysis to perform controlled topological simplification?
29. Explain a simple strategy to compute an approximation of a function on a PL manifold that preserves a user specified subset of extreme and has no further extrema!