Voicu Popescu, fall 2009

Sample exam questions

1. Given a planar pinhole camera *PPHC(a, b, c, C)* and a 3D point *P*, derive the *(u, v)* image plane coordinates of the projection of *P* with *PPHC*.

2. Given a circle *CC* of center *O*, normal *n*, and radius *r*, construct and position a planar pinhole camera that has a horizontal field of view of *hfov* degrees, a horizontal image resolution of *w* pixels, and projects the circle *CC* to a circle tangent to the image frame.

3. Given two planar pinhole cameras $PPHC_0(a_0, b_0, c_0, C_0)$ and $PPHC_1(a_1, b_1, c_1, C_1)$, derive an intermediate view obtained by linearly interpolating between the two given cameras.

4. Given two lines in 3D specified with a pair of 3D points, write a function that decides whether they intersect and, if they do, returns the intersection point.

5. Devise an algorithm for rasterizing convex polygons in 2D.

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7. You shade a triangle by screen-space vertex-color interpolation. Show that the red channel of an interior pixel is as bright as or brighter than the red channel of at least one of the 3 vertices.

8. When rasterizing a triangle, when do screen space and model space interpolation of rasterization parameters produce the same results?

9. A texture of 256x256 resolution is mapped to a square. A graphics application renders the texture mapped square with nearest neighbor lookup. What problems can occur?

10. When modeling a room with a planar mirror on one of its walls, can texture mapping be used to render the mirror? Explain. How could one render the planar mirror correctly?

11. Assume you render a complex scene with a planar pinhole camera PPHC(a, b, c, C) with a 150 by 150 degree field of view and a 2,000 x 2,000 image resolution. Describe a rendering algorithm that lets a user explore the scene with a pinhole camera with a 45 x 45 degree field of view and a 256 x 256 image resolution, from the same viewpoint C, without re-rendering the scene, by reusing the large pre-computed image.

12. Same as 11 except that the user should now be allowed to translate away from C.

13. You render a 3D scene using a planar pinhole camera $PPHC_0$ with a field of view of 50 degrees to obtain an image I_0, then you pan the camera 20 degrees to $PPHC_1$ and

render the scene again to obtain image I_1. You then replace the scene with two quads that model the image planes of $PPHC_0$ and $PPHC_1$, texture mapped with I_0 and I_1 respectively. Finally you render this new scene with a planar pinhole camera $PPHC_{01}$ which is half way between $PPHC_0$ and $PPHC_1$ ($PPHC_0$ panned 10 degrees). Will you see a vertical seam in the image? Explain.

14. A fly walks on a wall with constant speed. A planar pinhole camera observes the scene. The fly appears to walk in the image with greater and greater speed. Explain.

15. Describe an approximate method for measuring the field of view of a digital camera.

16. Describe a procedure for tessellating a cone.

17. The latitude/longitude sampling of spheres oversamples at the poles. Describe a procedure for a more even sampling of the sphere surface.

18. Describe a procedure for tessellating a torus (doughnut).

19. Describe a fast procedure for collision detection. The objects are modeled with shared vertex triangle meshes.

20. Consider a world made of cubes, which is transformed into a huge shared vertex triangle mesh. Describe a fast procedure for eliminating the internal faces. An internal face is a face shared by two cube elements, and appears twice in the list.

21. You are given a shared vertex triangle mesh. Some pairs of triangles form squares, and you would like to not draw the diagonal. Describe a fast procedure for finding these pairs of triangles.

22. Devise a compound camera model that has a higher resolution in a sub-region of its field of view. Specify the vectors and points that define the camera, a constructor, a function that gives the ray captured at pixel coordinates (u, v), and a function for projecting a point $P(x, y, z)$.

23. You are shown a video. The camera motion used was either forward translation or zoom in. How do you decide which one it was?

24. A 3D scene that consists of 2 points is viewed using an interactive graphics application. How do you decide which point is closer to the camera?

25. Does the angle subtended by a pixel vary in a planar pinhole camera? If yes, how?

26. You render a cube but your z-buffer logic is wrong. What does the image look like?

27. When you render with a pinhole camera for which the pixel height is greater than the pixel width, do the objects appear taller or shorter in the image? Explain.

28. Describe a procedure for transforming an image with rectangular pixels in an image with square pixels.

29. You have rendered a 3D scene. You have the color buffer *CB*, the z buffer *ZB*, and the view *V* used to render the scene. Describe using *CB*, *ZB*, and *V* to render the scene from a different view. What problems could arise?

30. You have rendered a 3D scene. You have the color buffer *CB*, and the view *V(a, b, c, C)* used to render the scene. Describe using *CB*, and *V* to render the scene from a view *V'(a', b', c', C)* that has the same center of projection as *V*.

31. Describe a procedure for recovering the normals of a diffuse surface using a point light source and a camera.

32. Describe a procedure for deciding whether a surface is specular or not.

33. You are given a 3D scene lit by a point light source. Describe a procedure for rendering the scene with shadows.