Final Exam Review
CSCI-4965: Three-Dimensional Computer Graphics

1 Final Exam

The final exam will be held in DCC 330 on Thursday, December 14, 2000 from 8:00 am to 11:00am. The exam will be closed book and closed notes.

The final exam covers **all** material covered in class upto and including the lecture of December 4, 2000. The list of topics will be available on the course web page. This review focuses on material after the midterm exam. The review questions are only suggestive of questions you will see on the final; they are not comprehensive in their scope.

2 Review Questions

1. You are given a cylinder aligned with the Z axis, running from $z = 0$ to $z = 3$, and whose radius is 1. You are given a texture map whose s coordinates range from 0 to π, and whose t coordinate ranges from 0 to 1. You are to wrap this texture around the cylinder. Give the inverse mapping function, which maps a point (x, y, z) on the cylinder to the corresponding point (s, t) on the texture.

2. If a texture map is stored as a 512×512 image with 24-bit color, what is the additional storage required to store a mipmap?

3. True or False:

   (a) Texture rendering using linear interpolation can lead to distortions in the texture.

   (b) OpenGL provides support for 3D texture mapping.

   (c) Bump mapping changes the geometric shape of the bump mapped surface.

   (d) Environment mapping is typically performed using a cube or sphere mapping.

4. State an example application of image compositing.

5. True or False:

   (a) A pixel with an alpha value of 1 corresponds to an opaque pixel.

   (b) The alpha channel can be used for antialiasing.

   (c) Image morphing typically requires knowledge of the correspondence between the source and target images.

6. Consider a polygonal face f with outward normal vector $\vec{n} = (5, -3, 2)$ and a viewing vector $\vec{v} = (1, 1, 2)$. Is face f a front or back face?

7. True or False:

   (a) Back face culling is supported in OpenGL.

   (b) For a scene with multiple convex polyhedra, visible surface detection can always be performed by back face culling.

   (c) OpenGL uses the z-buffer (depth buffer) algorithm for visible surface detection.

   (d) When using the depth sort algorithm (Painter's algorithm), surfaces can be scan converted in arbitrary order.

8. Suppose visible surface detection is being performed by the Z-buffer algorithm using a z-buffer with b bits of depth. Assuming the image resolution is 1024×1024, what is the memory required for the framebuffer?

9. True or False:

   (a) The BSP tree for a scene is computed in a viewpoint independent manner.

   (b) The performance of a BSP tree representation is not influenced by the selection of splitting planes.

   (c) Ray casting for visible surface detection is a view dependent technique.

10. When creating a BSP tree, polygons in the scene can be used to split the scene. What is an advantage of permitting planes other than those passing through the scene polygons to split the scene?

11. Consider any two methods for visible surface detection and state an advantage and disadvantage of each method.

12. True or False:

   (a) Ray tracing does not account for indirect illumination due to reflection and transmission from intermediate surfaces.

   (b) Ray tracing typically uses the Phong illumination model for local illumination.

   (c) Spheres are easier to ray trace than polyhedra.

13. Consider a scene with l light sources that is to be ray traced. Let the maximum depth of the ray tree be d_{max} (where a depth of 1 corresponds to the first intersection of the primary ray with a surface). Assume a single ray is generated per pixel.

   (a) Compute the maximum number of reflected and transmitted rays generated.

   (b) Compute the maximum number of shadow rays generated.

   (c) Compute the maximum total number of rays generated if the image resolution is 1024×1024.

14. What is the advantage of supersampling a pixel during ray tracing?

15. Assume a ray is refracted as it moves from a medium with refractive index η_i to a medium with refractive index η_r. What is Snell's law? How is the angle of refraction θ_r of the transmitted ray computed from the angle of incidence θ_i?

16. Compute the intersection points of a ray $P_0 + s\hat{u}$ with the sphere of radius 5 located at $(0, 10, 0)$. Assume $P_0 = (3, 0, 0)$ and $\hat{u} = (0, 1, 0)$.

17. Determine whether the ray with origin point $P_0 = (0, 0, 0)$ and unit direction vector $\hat{u} = \frac{1}{\sqrt{3}}(-1, 1, 1)$ intersects the triangle specified by vertices (in ccw order) $(1, 0, 0), (0, 1, 0), (0, 0, 1)$.

18. What is the total number of frames in a 1 hour long movie that runs at 24 frames per second?

19. Mention an advantage of using interpolating splines over linear interpolation for keyframe interpolation.

20. Mention an advantage of using Hermite or Catmull-Rom splines for generating inbetween frames for keyframe interpolation.

21. Mention two representations for an hierarchical object model.

22. True or False:

    (a) The squash and stretch principle in animation uses shape distortion to indicate physical properties of an object.

    (b) In OpenGL, tree traversal to render a hierarchical object can be implemented using the modelview matrix stack.

    (c) Kinematics takes into account the forces that cause motion.

23. Mention a reason why animating human motion is difficult.

24. Describe the difference between forward kinematics and inverse kinematics.

25. When motion capture data gives us the motion of instrumented joints of an actor, we use inverse/forward kinematics to animate the motion of a corresponding graphical character.

26. Mention a limitation of using motion capture data.

27. List three objects or phenomena that can be modeled using particle systems.

28. Name two techniques used to model plants and grass.

29. True or False:

    (a) The evolution of a particle system is governed by deterministic rules.

    (b) Flocking behavior can be simulated using simple rules to govern the motions of individual members of a flock.

    (c) Character animations in computer games are typically generated using motion capture data.

30. True or False:

    (a) The fractal dimension of a fractal curve can be greater than 1.

    (b) Fractals such as the Sierpinski gasket can be computed by a recursive procedure.

    (c) Fractal terrains to model mountains can be generated using random midpoint displacement techniques.

31. Compute the fractal dimension of the Koch curve.

32. Let the perimeter of an equilateral triangle be p. What is the perimeter of the Koch snowflake generated from it after 2 iterations?

33. Compute the sequence of the first three complex points generated by the function $z_{k+1} = z_k^2 + c$ where $c = -1 + i$ and $z_0 = 0$. Do you think c belongs to the Mandelbrot set?

34. Mention an advantage of using shape grammars for object modeling.

35. Give a reason for introducing randomness in the application of rules when generating plants or trees using L-grammars.