EXAM
DH2320 Computer Graphics and Visualization
2012-12-15

Teacher: Marcus Nilsson, marcuni@kth.se

Aids: None

The exam consists of 10 questions. The number of points awarded for a correct answer is stated next to each question. The maximum score is 22. To pass the exam, you need at least 13 points.

Write legibly! Answers that I cannot read will receive 0 points! When explaining, try to be as concise and clear as possible! Answers that I cannot understand will receive 0 points! Feel free to use figures/sketches to complement your written explanations.

Good luck! / Marcus

Question 1 (2p): Describe preferably with a sketch what this WebGL code will produce. Only the important part of the code is included.

```
…
vertices = [ 0,0,0, 0,1,0, -1,0,0,
             0,0,0, 1,0,1, 0,-1,0];
…
colors = [ [ 0.0, 0.0, 0.0, 1.0 ],
           [ 1.0, 1.0, 1.0, 1.0 ]];
…
mat4.translate(mvMatrix, [ 0.0, 0.0, -5.0 ]);
mat4.rotate(mvMatrix, 45*Math.PI / 180, [ 0, 0, 1 ]);
…
gl.drawArrays(gl.TRIANGLES, 0, 6);
…
```

Answer:
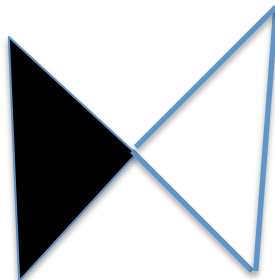
Question 2 (2p): In OpenGL/WebGL, what are object coordinates? What are eye coordinates? What is the relationship between them?

Answer: In WebGL, geometry is specified in object coordinates, i.e., the coordinate system that is local to a 3D model or mesh. The object coordinates are multiplied by the modelview matrix, which transforms them into eye coordinates. Eye coordinates are the "world coordinates" of WebGL: the camera is defined as being at $(0, 0, 0)$ in eye coordinates, looking down the negative z axis. By manipulating the modelview matrix, a model can be positioned (or transformed linearly) in relation to the WebGL camera origo.

Question 3 (2p): What is a depth buffer? How does it differ from a color buffer? Explain how a depth buffer can be used in real-time graphics!

Answer: A depth buffer has the same size as the color buffer but instead of colors it contains the distances in 3D space along the z axes. A depth buffer can be used to ignore part of objects that are hidden by other objects and with that being able to save resources.

Question 4 (2p): Describe the difference between an interpolating spline and a Bezier spline!

Answer: An interpolating curve runs through all four control points used while a Beizer spline uses the point 2 and 3 as direction vectors for the tangents at the end points of the spline.
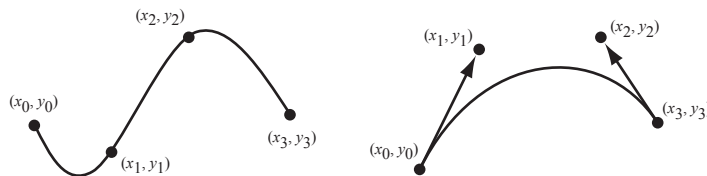
Question 5 (3p): The Phongs reflection model is a sum of three terms that each models a specific type of light reflection. Name and describe the three terms!

Answer:
Ambient reflection, A constant value that represent light that has arrived from other surfaces in the scene
Diffuse reflection, An idealized kind of reflection that spreads the incoming light evenly in all direction around the surface normal. Gives a matte look
Specular reflection, Another idealized type of reflection were the incoming light is reflected at an equal angle direction around the surface. Creates highlights

Question 6 (2p): In animation, describe the principle of anticipation!

Answer: Anticipation is the principle that an action does in most cases not just happen but there is a preparation for the action. By including this preparation in the animation it becomes more natural. The way the preparation is done also helps define the strength of the action that will be taken.

Question 7 (2p): Describe the difference between key frame animation and inverse kinematics!

Answer: In key frame animation, the motion for each hierarchical model joint (e.g., shoulder, elbow, wrist) is defined explicitly by the animator, by specifying their angle at specific points in time. The computer then interpolates between these key frames. As a result, the XYZ location of the end joint (e.g., the hand) is determined from the "top down" (shoulder → elbow → wrist). In inverse kinematics, the motion is implicit: the animator specifies the XYZ location of the end joint (the hand) and the joint angles are computed by solving a linear system of equations. As a result, the motion is determined from the "bottom up" (wrist → elbow → shoulder).

Question 8 (1p): Describe the visualization encoding that is best for most data and a situation when it is impossible to use it.

Answer: Position is the best encoding for most type of data. It cannot be used when describing data that is location specific like the air pressure distribution in a room.

Question 9 (4p): The course notes describe a user-centered visualization design process with five steps. Describe this process!

Answer:
- Users and Context
    - Find out the context and the users that will use the visualizstion. What are the questions that it should answer, outcome is set of requirements
- Platforms
    - What platform supports the requirements and data that are being considered? Outcome is a set of technical requirements.
- Information design
    - How should the data be presented and how should the user interact with it. Outcome can be sketches or diagrams etc.
- Visual design
    - How is the look and feel, what colors and graphics should be used, outcome sketch, design prototype etc.
- Testing
    - Important to test a prototype with real users and iterate the process with the findings of the test.

Question 10 (2p): Why is the rainbow color map often a poor choice for encoding data in visualization?

Answer: The rainbow color map tends to hide variation in regions of low contrast and appears less smooth in regions of high contrast making it hard to distinguish between values that are in these regions.