TDA362/361/DIT223 Computer Graphics

EXAM

(Same exam for both CTH- and GU students)

Tuesday, August 27th, 2019, 14:00 - 18:00

Examiner
Ulf Assarsson, tel. 031-772 1775

Permitted Technical Aids
None, except English dictionary

General Information
Numbers within parentheses states the maximum given credit points for the task. Solutions shall be clear and readable. Too complex solutions can cause reductions in the provided number of points

Questions to examiner during exam
will be possible approximately one hour after the start of the exam. If anything is unclear – remember what has been mentioned on the lectures, in the slides and course book and do your best.

Grades
In order to pass the course, passed exam + exercises (or exam + project) are required. The final grade is calculated from the exam grade. The exam is graded as follows

CTH: 24p ≤ **grade 3** < 36p ≤ **grade 4** < 48p ≤ **grade 5**

GU: 24p ≤ **G** < 45p ≤ **VG**

Max 60p

Grades are announced by the LADOK system ~3 weeks after the exam

Solutions
will be announced on the course home page.

Review
Review date (granskningsdatum) is announced on the course home page.

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Question 1

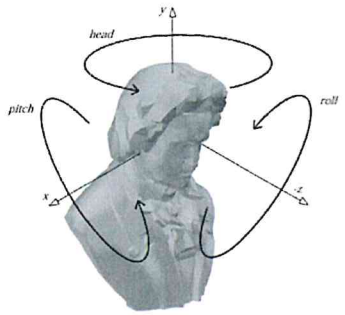
a) **[2p]** Which matrices are involved in the transformation of a vertex from model space to screen space? I.e., give the names for these matrices.

b) **[2p]** Explain screen tearing.

c) **[1p]** What is the advantage of Bresenham's line drawing algorithm?

d) **[1p]** What is the matrix to transform the normals, if matrix **M** is used to transform the positions?

e) **[3p]** Euler rotations can be used to describe the rotation of an object. The rotation is often defined by *head, pitch and roll*, which each is a rotation around one of the **world space** axes. E.g., the combined rotation is $\mathbf{M} = R_z(r)\, R_x(p)\, R_y(h)$, where R_i rotates around the world space axis i. Question: Is **M** dependent on the multiplication order of R_x, R_y, and R_z? Motivate your answer well.



f) **[1p]** For directions we generally want the fourth component, w, to be set to zero while for positions we set it to one. Why?

Question 2

a) **[3p]** State 3 fundamentaly different types of aliasing problems within computer graphics. I.e., aliasing problems at three fundamentaly different situations.

b) **[1p]** What is the difference between supersampling and multisampling?

c) **[1p]** Describe how anisotropic filtering works. Also tell why it is needed.

d) **[1p]** Draw the Quincunx pattern and state the weights per sample.

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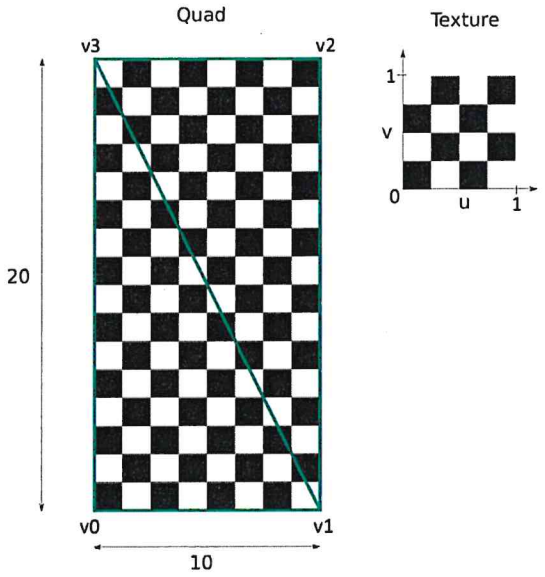
e) **[2p]** Assume you want to texture a quad with a repeating chessboard pattern (see the figure). You start by setting the texture wrap option to REPEAT. What texture coordinates (u,v) should you specify for each vertex v0,v1,v2,v4 to achieve the desired effect?



f) **[2p]** Why does not (classic) environment mapping (e.g., the ones taught in the course) work well for **planar** reflections? (Your answer can preferably include an illustration. As an example, you could use a man standing on a floor, where the man should reflect in the reflective floor.)

Question 3

a) **[3p]** What is a vertex shader, geometry shader and fragment shader? Explain their functions, respectively.

b) **[1p]** How can you implement fog using the fragment shader?

c) **[1p]** Normally, you would want to draw all geometry that is in front of the camera. So, why is a near and far plane used for the view frustum?

d) **[3p]** Describe a method for an intersection test between a ray and a triangle in 3D.

e) **[2p]** Show how to compute the intersection between a ray and an infinite cylinder (all in 3D), centered on the z-axis.

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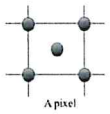
Question 4

a) **[1p]** Where in the tree are the triangles stored for a Polygon-aligned BSP-tree?

b) **[3p]** Explain Occlusion Culling, Detail Culling, View Frustum Culling, Portal Culling, Backface Culling and Levels of Detail.

c) **[1p]** What is the point of using **dynamic** collision detection tests?

d) **[3p]** Assume that you are implementing adaptive super sampling in your ray tracer. Give pseudo code for using the recursive sampling scheme given to the right (including using the correct weights). (The image here illustrates one pixel with the first five samples.)



e) **[2p]** Explain how a skippointer tree works and what the advantage is?

Question 5

a) **[2p]** Why do we want to use Final Gather when using photon mapping?

b) **[1p]** How are soft shadows from an area-light source computed with **path tracing**?

c) **[2p]** Two separate photon maps are constructed during photon mapping. **Which** and **why**?

d) **[2p]** Explain why light leaks and z-fighting can occur when using shadow maps.

e) **[3p]** Describe the shadow map algorithm.

Question 6

a) **[1p]** Sketch one non-continuous curve and one C^0-continuous curve (and mark which is which).

b) **[1p]** What is the potential advantage and disadvantage of Bezier-curves compared to Hermite curves? (Think of a user that has to specify the curves)

c) **[2p]** In which ways are NURBS more general than B-Splines?

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d) **[1p]** Assume **p**=(0,1,9,6). Perform the homogenisation step on **p**.

e) **[1p]** Manually normalize the vector **x**=(5,4,2).

f) **[2p]** There are 4 main taxonomies of hardware, based on where in the GPU-pipeline sorting in screen space is done. Which are these four? (Names are enough. You do not need to describe them if you don't want to.)

g) **[2p]** Assume that you are a hardware designer of a modern GPU working at some company. What would be the main point on your wish list: being able to increase the GPU core clock frequency or being able to increase the memory bandwidth? **Motivate!**

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