Written exam in EDAN35

"High Performance Computer Graphics"

Department of Computer Science, Lund University

Six questions, each worth 1.0 points

Allowed aids: none

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Remember to answer the questions as thoroughly as you can without diverging from the question. You should strive to give as clear a picture of your understanding as possible. Ensure that you write so that someone other than yourself can read it. Please answer in english.

1: Rasterization

a) [.2p] What role does an edge function play in rasterization? How does the edge function do this?

b) [.2p] Write down the equation for an edge function and explain the variables you used.

c) [.3p] Describe how to compute barycentric coordinates from an edge function. Use equations to explain your answer.

d) [.3p] Describe how edge functions can be used to do perspective correct interpolation of a triangle's vertex attributes for a specified pixel?

2: Deferred Shading and Shadows

a) [.2p] Explain the benefit of using Deferred Shading instead of basic rendering.

b) [.3p] What values do you need to store in the deferred shading geometry buffer and how are they used.

c) [.3p] Explain a method for computing shadows. Include what rendering passes you need, their projections and comparisons of values.

d) [.2p] Give an example of an artifact you could get using the shadow technique you described previously and how you can fix those artifacts.

3: Texturing and miscellaneous
a) [.2p]Describe how trilinear mip-mapping works. Describe the input data and how it is processed mathematically.

b) [.1p] How does trilinear mip-mapping affect texture cache performance?

c) [.2p] To implement texture decompression in the hardware of a GPU, the texture compression/decompression algorithm must have certain characteristics. Motivate two of these characteristics. (Hint: it must be quite different, from say JPEG)

d) [.2p] If you drew all the front facing triangles of an object first. Then drew only the back facing faces, but you moved the back facing faces slightly closer to the eye, what effect would this result in. Draw a diagram to explain your answer.

e) [.3p] How does rasterization traversal effect performance on the GPU? Describe a method of traversal that improves GPU performance and enables other GPU performance algorithms. Describe how your method enables other GPU performance algorithms.

4: Fixed-point and Performance analysis
a) [.3p] Take a look at the following code, which uses four floating-point numbers, `af`, `bf`, `cf`, and `df`:

```
int a=floatToFixed(af,4);
int b=floatToFixed(bf,2);
int c=floatToFixed(cf,2);
int d=floatToFixed(df,2);
int e = a+b*c*d;
```

Obviously, the programmer wants to add `a` to the product between `b, c,` and `d` in fixed point. Change the last line of the code so that the intended result (without any loss of information) is obtained, and so that as few fractional bits as possible are used (how many is that?).

b) [.1p] Explain the term depth complexity.

c) [.2p] From depth complexity another measurement can be determined called overdraw. Explain what overdraw is. If a scene has a depth complexity of 4, compute the overdraw and show how you computed it.

d) [.2p] Create new terms for bandwidth from the major operations in a GPU, and combine them with the terms depth complexity and overdraw to write an equation that calculates an estimate of total memory bandwidth.

e) [.2p] If the depth cache miss ratio is m_d and the texture cache miss ratio is m_t, improve the estimate that the previous equation estimates by adding these terms to your equation.

5: Z Culling and compression
a) [.4p] Culling using a single Z value for an entire tile can be used to improve bandwidth usage. Describe two types of per tile Z culling that can be implemented in a GPU. In your description explain what Z values must be stored, the position of the new tile and which Z bandwidth is saved. Use diagrams to clarify your answer.

b) [.3p] What steps must be performed to update zmin and zmax value per tile? Include what data you may need to read from memory and efficient ways to compute zmin and zmax for the current tile of the current triangle you are rendering.

c) [.3p] Describe a depth compression scheme that provides a high compression ratio. Either one from the lectures or invent your own. Explain the features of your chosen scheme and give reasons why your scheme is better than other possible schemes.

6: Architecture and Antialiasing
a) [.3p] Draw a labelled diagram of the 6 stages of a straight (non-unified) Graphics Processing Unit (GPU) pipeline. (0.05 points for each labelled stage).

b) [.1p] Redraw the diagram from the previous question, but now with a unified shader.

c) [.2p] GPUs are massively parallel with thousands of arithmetic units. Describe 2 ways in which GPUs are different to CPUs and explain why that difference exists.

d) [.2p] Make a drawing of the sampling positions of Rotated Grid SuperSampling (RGSS). Indicate (with numbers) exact positions of samples.

e) [.2p] Describe and draw a possible set of sampling positions that could include the benefits of RGSS, but use fewer samples per pixel on average. Describe how your suggested sampling pattern incorporates the advantages of RGSS.

The end!

Course evaluation
Please answer the questions below. You can detach this page, and hand it in anonymously.

	Fully disagree				Fully agree
1. This course was fun and enjoyable	☐	☐	☐	☐	☐

2. What did you like about this course?

3. What did you not like about this course?

4. What would you like more of in this course?

5. What would you like less of in this course?

6. What did the type of examination (assignments, project, written exam) mean to your learning?

7. What did you think about the goals (i.e., what you should learn) in this course?

General comments