Computer Science Department
Stanford University
Comprehensive Examination in Graphics
Autumn 1999

November 4, 1999

READ THIS FIRST!

1. Please write your answers directly on the exam. Use scratch paper to work Out the problem, and then put the answer on the test. No blue books needed.

   The exam takes 60 minutes.

2. This exam is OPEN BOOK. You may use notes, articles, or books—but no help from other sentient agents such as other humans or robots.

PLEASE WRITE YOUR MAGIC NUMBER HERE: ________________

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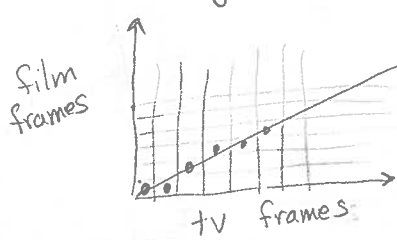
Computer Graphics Comprehensive Exam – November 1999

This exam is **OPEN BOOK**. You have **60 minutes** to complete this exam. Write your answers on the empty spaces after each question and try to be as concise as possible.

1: Film is usually shot at 24 frames per second, while American TV sets display at 30 frames per second. Thus, when motion pictures are transferred to video they must undergo a process called "pull-down" to match the higher frame rate.

a) [5 pnts] Explain how the "pull-down" problem (what film time-frame is displayed at what video time-frame) can be solved by a scan-conversion line-drawing algorithm. (be concise, a drawing helps too).

resampling the film is like rasterizing a line:



finding the best pixels for this line corresponds to finding correspondences between tv-frames and film frames

b) [5 pnts] Suggest an appropriate line-drawing algorithm, and fill in the film frames using this algorithm:

Midpoint algorithm works fine

0 1 2 3 3 4 5 6 6½ 7 8 9 10 10 11 12

Film	1	2	2	3	4	5	6	6	7	8	9	10	10	11	12
Video	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

.133 .2 .266 .33 .4 .466 .533 .6 .666 .733 .8 .866 .933 1

2: [10 pnts] Give a 4x4 matrix that transforms a set of 3D homogenous coordinates by first rotating them 90 degrees counter-clockwise around the Z-axis, translates them 5 units along the Y-axis, and enlarges them by 2 in all 3 dimensions. (You can express your answer with a sequence of matrix multiplications, instead of one single final matrix).

enlarge, translate, rotate

$$\begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 5 \\ 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 & -1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & & 1 \end{bmatrix}$$

$\cos 90° = 0$

$\sin 90° = 1$

3: [10 pnts] Given one viewer with center of projection (0,0,0) and a view plane through (0,0,1) perpendicular to the Z-axis who sees point P in 3D projected as P1=(x1,y1), and given another viewer with center of projection (1,0,0) and view plane through (0,0,1) perpendicular to theZ-axis who sees the **same** point P in 3D projected as p2 = (x2,y2), what are the coordinates of P in terms of x1,y1,x2,y2?

4: [10 pnts] What is the minimum number of vertices needed to define a single B-spline surface patch of order k ? (Assuming all vertices are of multiplicity 1)

order k → degree k-1

n+1 points
d-1 degree
n+d+1 knots

d=k

# of points that affect any part of curve.

For min # of points, they all affect each part of the curve (k points).

2D → k^2 points

5: [10 pnts] Given two colors A and B represented in HSV space as A = (20,0.2,0.8) and B = (320,0.6,0.6), what is the HSV representation of the color containing ¾ of color A and ¼ of color B? Do the interpolation in HSV space

6: [10 pnts] Some special cases which cause problems for some hidden-surface algorithms are penetrating faces and cyclic overlap. A penetrating face occurs when polygon A passes through polygon B. Cyclic overlap occurs when polygon A is in front of polygon B, which is in front of polygon C, which is in front of polygon A. Discuss briefly for following 5 algorithms whether they can handle penetrating faces and cyclic overlap or how they need to be modified for these cases.

a) Z-Buffer:

b) Depth Sort:

c) Scan Line:

d) BSP:

e) Warnock Subdivision: