Colour, displays and image processing

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From Supervision 2

1. Derive the conditions necessary for two Bézier curves to join with:

   Consider two bezier curves $p(t)$ and $q(t)$, defined by control points $(p_0, p_1, ..., p_n)$ and $(q_0, q_1, ..., q_n)$ respectively.

   (a) just C0-continuity

   $C0$ continuity can be achieved by setting $p(1) = q(0)$ giving:

   $$q_0 = p_n$$

   (b) C1-continuity

   $C1$ continuity can be achieved with the additional constraint that $p'(1) = q'(0)$ giving:

   $$q_1 - q_0 = p_n - P_{n-1}$$

   Which when combined with the above constraint gives:

   $$q_1 = 2p_n - p_{n-1}$$

   (c) C2-continuity

   For $C2$ continuity we must also have that $p''(1) = q''(0)$, giving:

   $$q_2 - 2q_1 + q_0 = p_n - 2P_{n-1} + p_{n-2}$$

   Which when combined with the above constraint gives:

   $$q_2 = p_{n-2} + 4(p_n - p_{n-1})$$

2. What would be difficult about getting three Bézier curves to join in sequence with C2-continuity at the two joins?

3. For a cylinder of radius 2, with endpoints $(1, 2, 3)$ and $(2, 4, 5)$, show how to calculate:

   (a) an axis-aligned bounding box

   Let m, n, and o represent the x, y, and z axes respectively.

   Let A and B be the endpoints such that $A_M <= B_M$.

   Let $\delta = \frac{\sqrt{(A_n - B_n)^2 + (A_o - B_o)^2}}{(A_m - B_m)^2 + (A_n - B_n)^2 + (A_o - B_o)^2}$

   $m_{min} = A_m - \delta \times r$
   $m_{max} = B_m + \delta \times r$

   (b) a bounding sphere

   The bounding sphere has midpoint that is half way between the two endpoints: $mid = (1.5, 3, 4)$

   The radius is the distance from the midpoint to a point on the edge of the cylinder.

   One such point is $(2, 4 + \sqrt{2}, 5 - \sqrt{2})$.

   Giving: $r = \sqrt{(0.5)^2 + (1 + \sqrt{2})^2 + (1 - \sqrt{2})^2} = 2.5$

4. Break down the following (2D!) lines into a BSP-tree, splitting them if necessary:

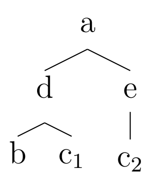
   a $(0, 0) - (2, 2)$

   b $(3, 4) - (1, 3)$

   c $(1, 0) - (-3, 1)$

   d $(0, 3) - (3, 3)$

   e $(2, 0) - (2, 1)$



5. (a) Compare the two methods of doing 3D clipping in terms of efficiency

Not sure which is more efficient - both require clipping against 6 axes.

(b) How would using bounding volumes improve efficiency of these methods?

Computing and storing bounding volumes for each object in the scene makes it much easier to quickly determine that two objects don't intersect.

6. Describe a complete algorithm to do 3D polygon scan conversion, including details of clipping, projection, and the underlying 2D polygon scan conversion algorithm.

7. Describe how you would form a good approximation to a cylinder from Bézier patches. Draw the patches and their control points and give the coordinates of the control points.

8. Given the following sixteen points, calculate the first eight of the next patch joining it as t increases so that the join has continuity $C1$. Here the points are listed with $s = 0$, $t = 0$ on the bottom left, with s increasing upwards and t increasing to the right:

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(-0.2, 3.4,  0.3)    (1.0, 3.1, 0.2)    (2.0, 2.6, -0.2)    (3.1, 2.8,  0.2)
( 0.0, 1.2,  0.4)    (1.2, 2.0, 1.2)    (1.4, 1.9, -0.2)    (2.7, 1.8,  0.2)
( 0.2, 1.0, -0.2)    (1.1, 0.8, 0.5)    (1.4, 1.0,  0.0)    (3.1, 1.1, -0.2)
( 0.0, 0.0,  0.0)    (1.0, 0.0, 0.5)    (2.0, 0.2,  0.4)    (2.7, 0.0, -0.2)
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Warmup Questions

1. Compare and contrast the use of LCDs and electrophoretic displays for screens in portable devices.
2. Compare the rendering in some different pieces of printed material. Use a magnifying glass to explore the resolution, colours and patterns used.

Longer Questions

1. Explain the use of each of the following colour spaces:
   (a) RGB
   (b) XYZ
   (c) HLS
   (d) Luv
2. Explain the difference between additive colour (RGB) and subtractive colour (CMY). Where is each used and why is it used there?
3. Compare the two methods of *Error Diffusion* described in the notes, with the aid of a sample image.