Reconstruction

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Textbook Chapter 17

Several slides courtesy of M. Kim

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Today

- Announcements
  - Next week will be devoted to course review (and brief discussion of optional topics)
  - Office hour today rescheduled due a conflict. New for this week: Thursday 11-12.
- Assignment 4 extension till Thursday midnight.
  - Note: if you still have grace days, the maximum allowed extension is till Sunday midnight.
- Reconstruction and Resampling

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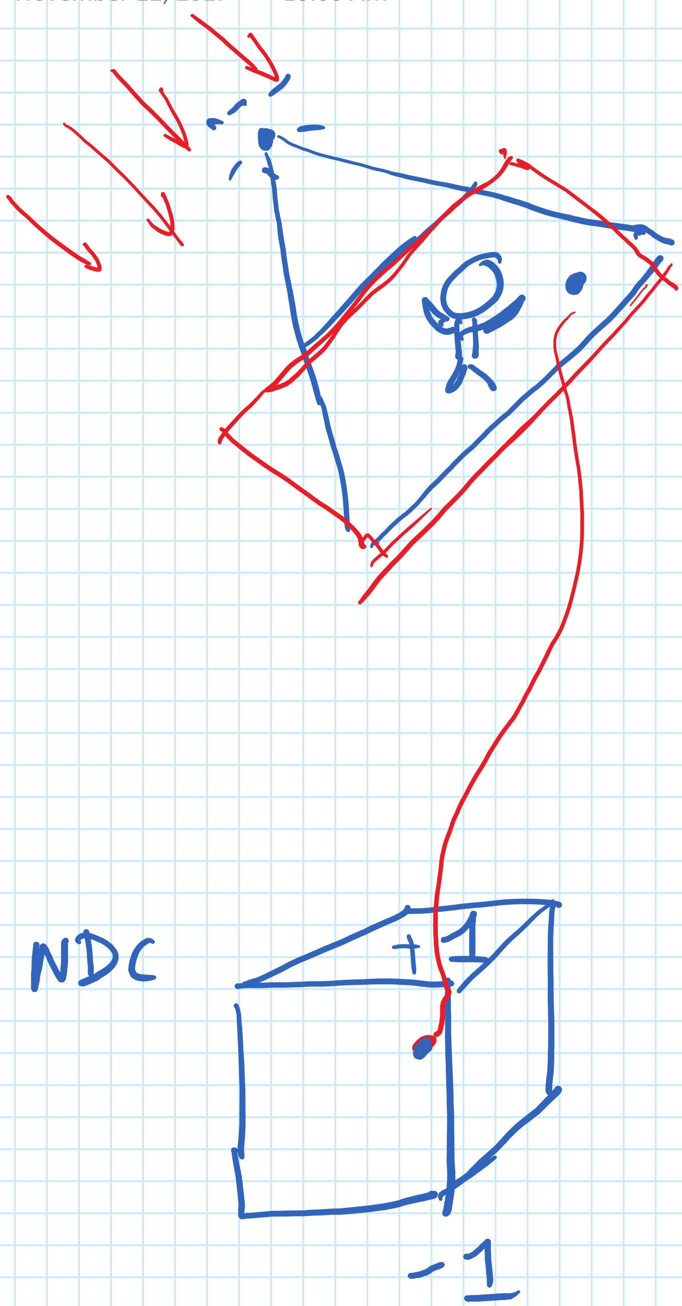
Shadow mapping recap for A4

November 22, 2017 10:00 AM



Step 1. Compute depth image

Note: depth.fs.glsl is storing depth in a "packed" format (for WebGL 1)

Step 2. While rendering the final image modify terrain shader

→ Need to transform a terrain position to light coord frame

→ Perspective divide (by w) yourself.

→ Find depth value using texture lookup of depth image

→ Remember NDC goes from -1 to 1

Convert to 0 to 1

Alpha blending

- Brief recap
  - Three.js examples https://threejs.org/examples/#webgl_materials_transparency
  - Clarification of a subtle point: "Premultiplied" and "non-Premultiplied" alpha
  - Note: .png files store non-premultiplied

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Recap: Alpha blending

- Associate with each pixel in each image layer, a value, $\alpha[\mathrm{i}][\mathrm{j}]$, that describes the overall *opacity* or *coverage* of the image layer at that pixel.
  - An alpha value of 1 represents a fully opaque/occupied pixel, while a value of 0 represents a fully transparent/empty one.
  - A fractional value represents a partially transparent (partially occupied) pixel.
- Alpha will be used during compositing.

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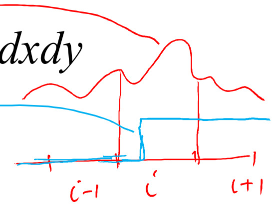
Alpha definition

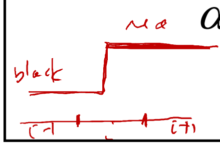
- More specifically, let $I(x,y)$ be a continuous image, and let $C(x,y)$ be a binary valued (x,y) *coverage function* over the continuous domain, with a value of 1 at any point where the image is "occupied" and 0 where it is not.
- Let us store in our discrete image the values:

This is called "Premultiplied"

$$I[i][j] \leftarrow \iint_{\Omega_{i,j}} I(x,y)C(x,y)dxdy$$

$$\alpha[i][j] \leftarrow \iint_{\Omega_{i,j}} C(x,y)\,dx\,dy$$





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Over operation

Note: a technical term

- To compose $I^f[i][j]$ over $I^b[i][j]$, we compute the composite image colors, $I^c[i][j]$, using
  $$I^c[i][j] \leftarrow I^f[i][j] + I^b[i][j]\,(1 - \alpha^f[i][j])$$
  That is, the amount of observed background color at a pixel is proportional to the transparency of the foreground layer at that pixel. This is for Premultiplied
- Likewise, alpha for the composite image can be computed as:
  $$\alpha^c[i][j] \leftarrow \alpha^f[i][j] + \alpha^b[i][j]\,(1 - \alpha^f[i][j])$$

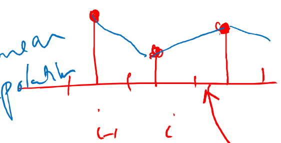
(+) More efficient

(−) Loss of precision at transparent points

Two major situations

Magnification

1 linear interpolation



Value between texels

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What's the value here?

2 lots of texels per fragment

Chapter 17

RECONSTRUCTION

(DISCRETE → CONTINUOUS)

Minification

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Reconstruction

- Given a discrete image I[i][j], how do we create a continuous image *I(x,y)*?
- Is central to resize images and to texture mapping.
  - How to get a texture colors that fall in between texels.
- This process is called *reconstruction*.
- We already know the key idea, from L23-L24: Interpolation! So we will go over this quickly.

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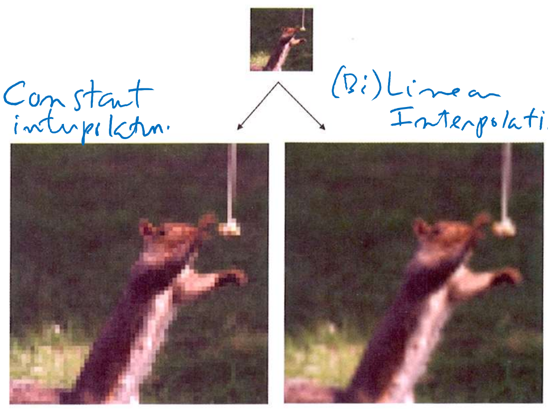
Constant reconstruction

- The resulting continuous image is made up of little squares of constant color.
- Each pixel has an influence region of 1-by-1

Constant interpolation.

(Bi)Linear Interpolation



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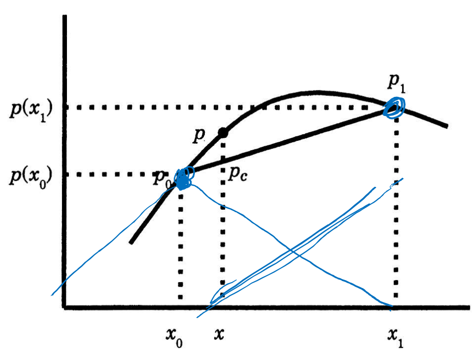
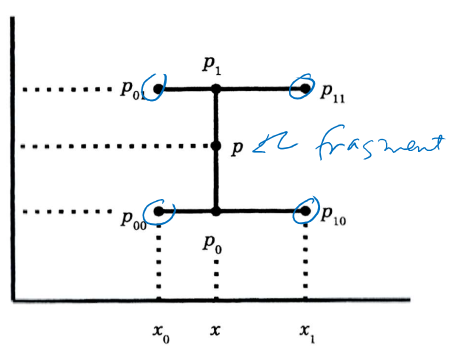
Linear and Bilinear interpolation

We already know how to interpolate in 1D

- Linear (1D)



Bilinear (2D):



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Bilinear reconstruction

- Can create a smoother looking reconstruction using *bilinear interpolation*.
- Bilinear interpolation is obtained by applying linear interpolation in both the horizontal and vertical directions. Pseudocode (not needed for WebGL)

```
color bilinearReconstruction(float x, float y, color
image[][]){
  int intx = (int) x;
  int inty = (int) y;
  float fracx = x - intx;
  float fracy = y - inty;

  color colorx1 = (1-fracx) * image[intx][inty] +
            (fracx) * image[intx+1][inty];
  color colorx2 = (1-fracx) * image[intx][inty+1] +
            (fracx) * image[intx+1][inty+1];
  color colorxy = (1-fracy) * colorx1 +
            (fracy) * colorx2;
  return(colorxy);
```


Bilinear properties

- At integer coordinates, we have *I(x,y)*=I[i][j]; the reconstructed continuous image *I* agrees with the discrete image I. => Interpolation
- In between integer coordinates, the color values are blended continuously.
- Each pixel influences, to a varying degree, each point within a 2-by-2 square region of the continuous image. => Local Support
- The horizontal/vertical ordering is irrelevant.
- Color over a square is bilinear function of (x,y).

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RESAMPLING

(RECONSTRUCTION+SAMPLING, DISCRETE→CONTINUOUS→DISCRETE)

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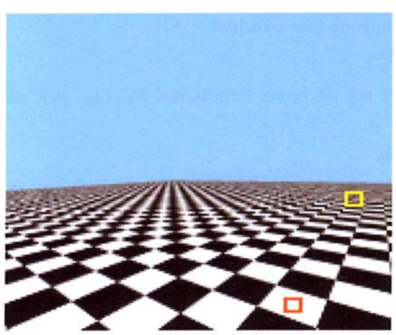
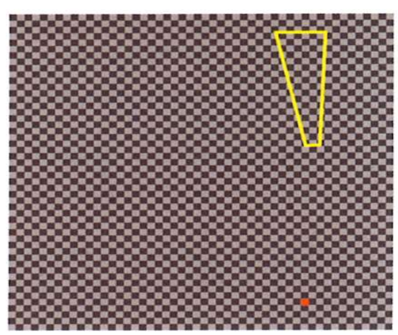
Resampling





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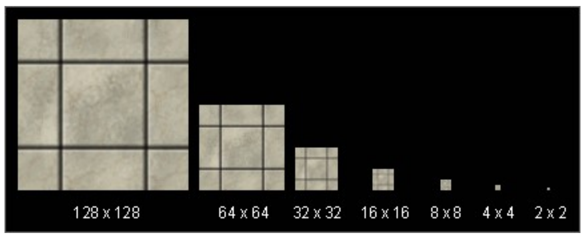
Mip mapping

- In mip mapping, one starts with an original texture T^0 and then creates a series of lower and lower resolution (blurrier) texture T^i.
- Each successive texture is twice as blurry. And because they have successively less detail, they can be represented with ½ the number of pixels in both the horizontal and vertical directions.



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