Resampling

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Textbook Chapter 18

Several slides courtesy of M. Kim

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Announcements

- I will be out of town on Friday. We will have a regular lecture, taught by TAs
  - Topic: a high level intro to Computer Animation and Geometric Modeling (roughly corresponding to Chapters 22 and 23 of text)
- The last class will be Monday April 7. Will review course and exam preparations.
- Assignment 3 grades now uploaded. Rest by the weekend
- TA evaluations at the end of the class (on paper)

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Recent example of using depth and compositing

- Depth cameras are now becoming available in mobile phones. Can use with compositing
- See http://www.engadget.com/2014/03/25/htc-announces-the-new-one/ video around 0:50

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Chapter 18

RESAMPLING

(RECONSTRUCTION+SAMPLING, DISCRETE→CONTINUOUS→DISCRETE)

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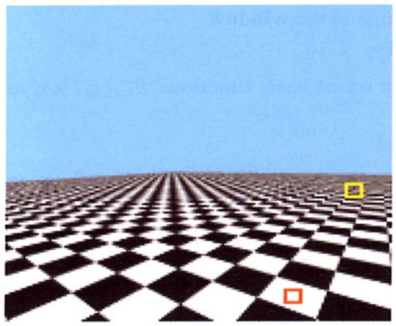
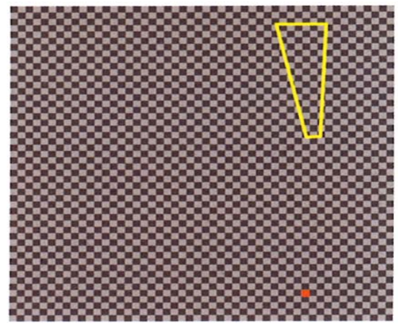
Resampling





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Resampling

- Lets revisit texture mapping
- We start with a discrete image and end with a discrete image.
- The mapping technically involves both a reconstruction and sampling stage.
- In this context, we will explain the technique of mip mapping used for anti-aliased texture mapping.

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(Textbook description) Resampling equation

- Suppose we start with a texture image (discrete) T[k][l] and apply some 2D warp to this image to obtain an output image I[i][j].
- Reconstruct a continuous texture $T(x_t, y_t)$ using a set of basis functions $B_{k,l}(x_t, y_t)$.
- Apply the geometric wrap (at the view point) to the continuous image.
- Integrate against a set of filters $F_{k,l}(x_w, y_w)$ (a box filter) to obtain the discrete output image.

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(Textbook description) Resampling equation

- Let the geometric transform be described by a mapping $M(x_w, y_w)$ which maps from continuous window to texture coordinates.
- We obtain:

$$\mathrm{I[i][j]} \leftarrow \iint_\Omega F_{i,j}(x_w, y_w)\left(\sum_{k,l} B_{k,l}[M(x_w, y_w)]\mathrm{T[k][l]}\right) dx_w dy_w$$

$$= \sum_{k,l} \mathrm{T[k][l]}\left(\iint_\Omega F_{i,j}(x_w, y_w)\left(B_{k,l}[M(x_w, y_w)]\right) dx_w dy_w\right)$$

(we could obtain an output pixel as a linear combination of the input texture pixels.)

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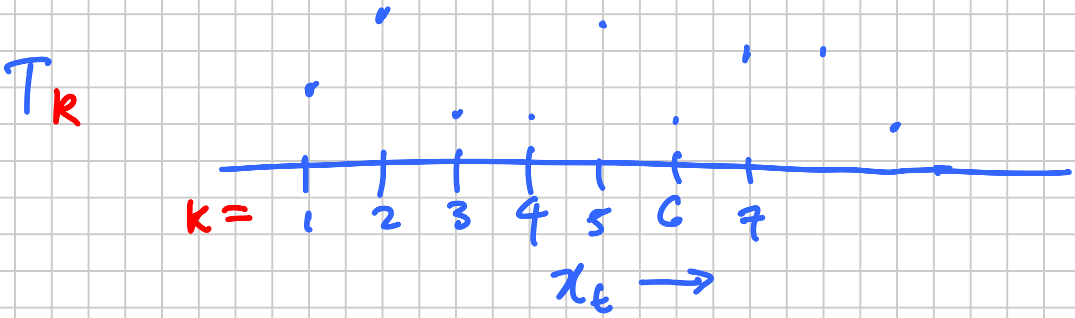
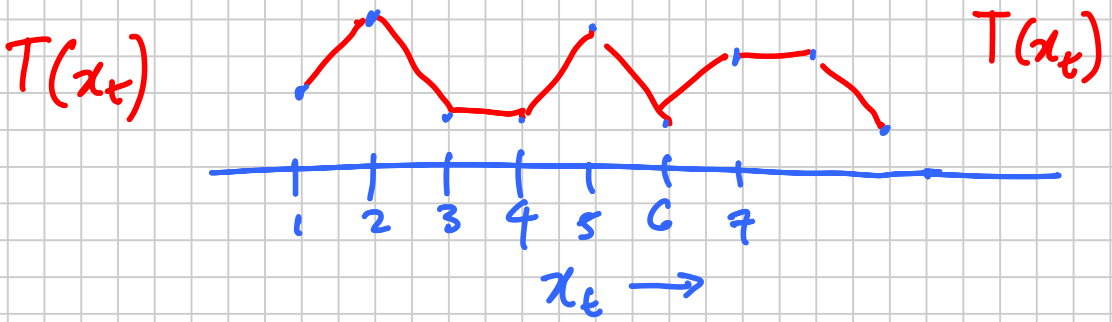
Resampling Intuition

Note Title 2014-04-02



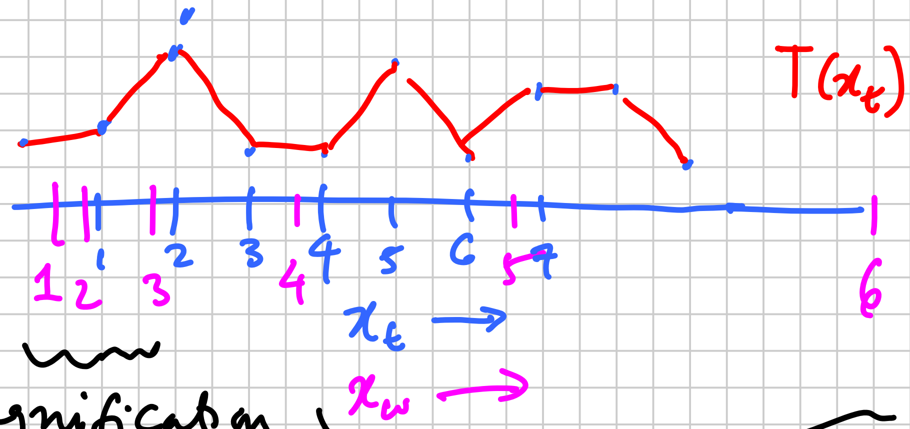
Reconstruction $\equiv$ Interpolation
ch. 17



$$T(x_t) = \sum_k B_k(x_t)\, T_k$$

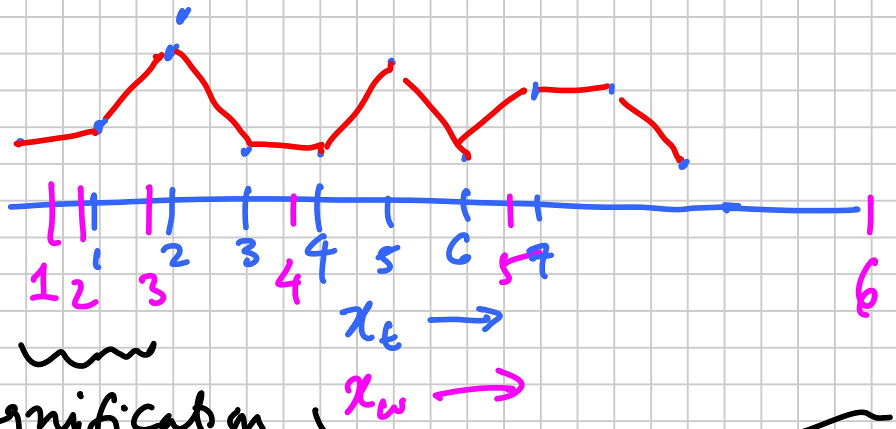
Viewport + Perspective, etc.

$x_w = N(x_t)$ or $x_t = M(x_w)$
could be complicated



Magnification
Pure sampling
Interpolation

Minification



Magnification

Pure sampling

Interpolation

- Constant $\equiv$ Nearest neighbor
- Linear

Minification

- Interpolation
  - Nearest
  - Linear
- Filter + Sample
  - Mipmaps
  - Pre Filter the texture
    - Nearest
    - Linear

§ Mipmapping

Magnification

- We tell OpenGL to do this using the call glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MAG_FILTER, GL_LINEAR).
- For a single texture lookup in a fragment shader, the hardware needs to fetch 4 texture pixels and blend them appropriately.

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Minification

- In the case that a texture is getting shrunk down, then, to avoid aliasing, the filter component should not be ignored.
- Unfortunately, there may be numerous texture pixels under the footprint of $M(\Omega_{i,j})$, and we may not be able to do our texture lookup in constant time.

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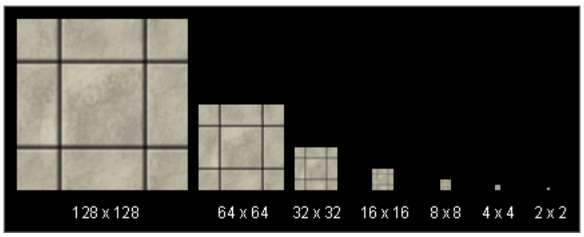
Mip mapping

- 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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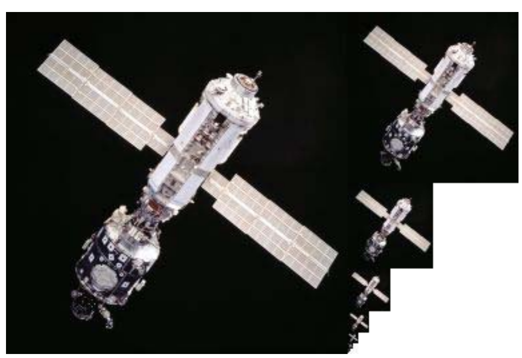
Mipmap example



Source: wikipedia

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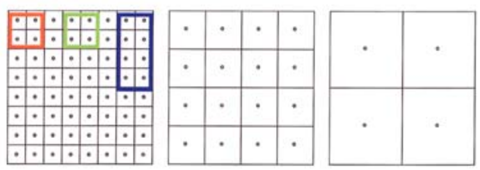
Mip mapping

- Mip mapping with trilinear interpolation is specified with the call glTexParameteri(GL TEXTURE 2D, GL TEXTURE MIN FILTER,GL LINEAR MIPMAP LINEAR)
- Trilinear interpolation requires OpenGL to fetch 8 texture pixels and blend them appropriately for every requested texture access.

this is OpenGL default! between levels within a texture



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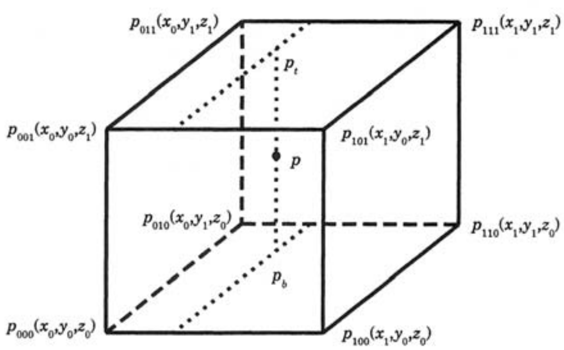
Trilinear interpolation



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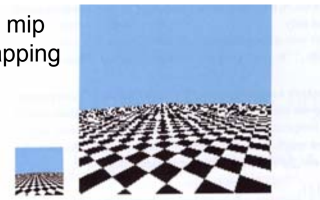
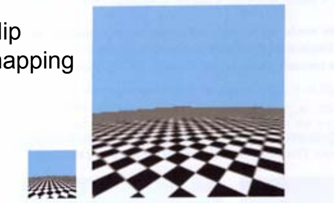
Properties

- It is easy to see that mip mapping works reasonably well, but has limitations that can be addressed by more advanced methods.

No mip mapping



Mip mapping



Anisotropic mip mapping