CS451 Texturing

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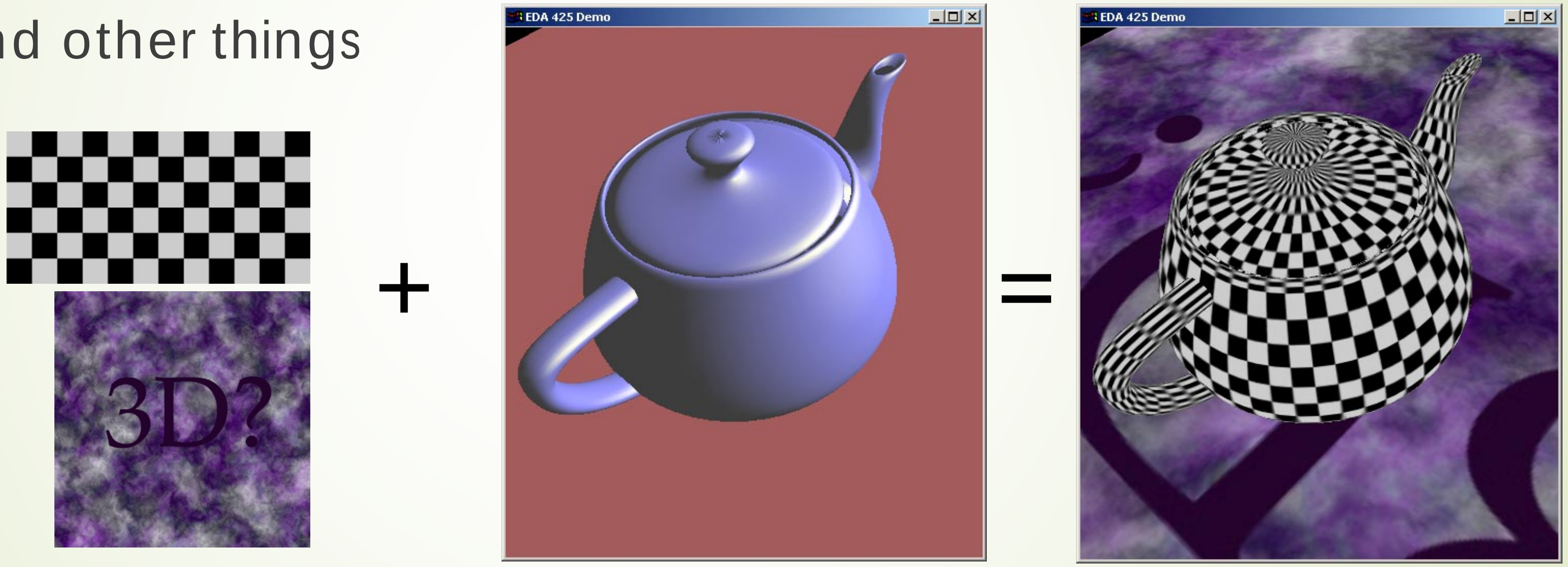
Based on Tomas Akenine-Möller's lecture note

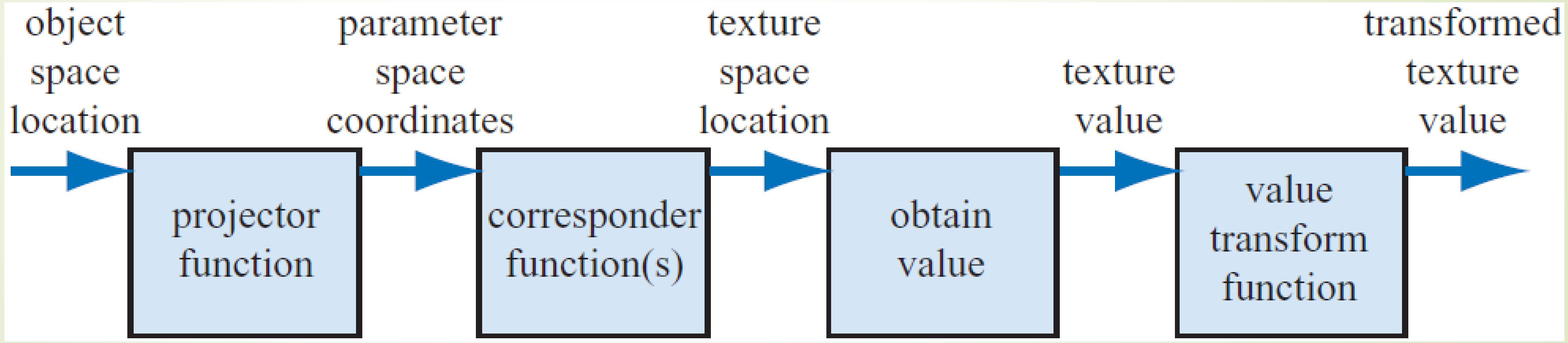
Texturing: Glue n-dimensional images onto geometrical objects

- More realism, and this is a cheap way to do it
  - Bump mapping
  - Plus, we can do environment mapping
  - And other things

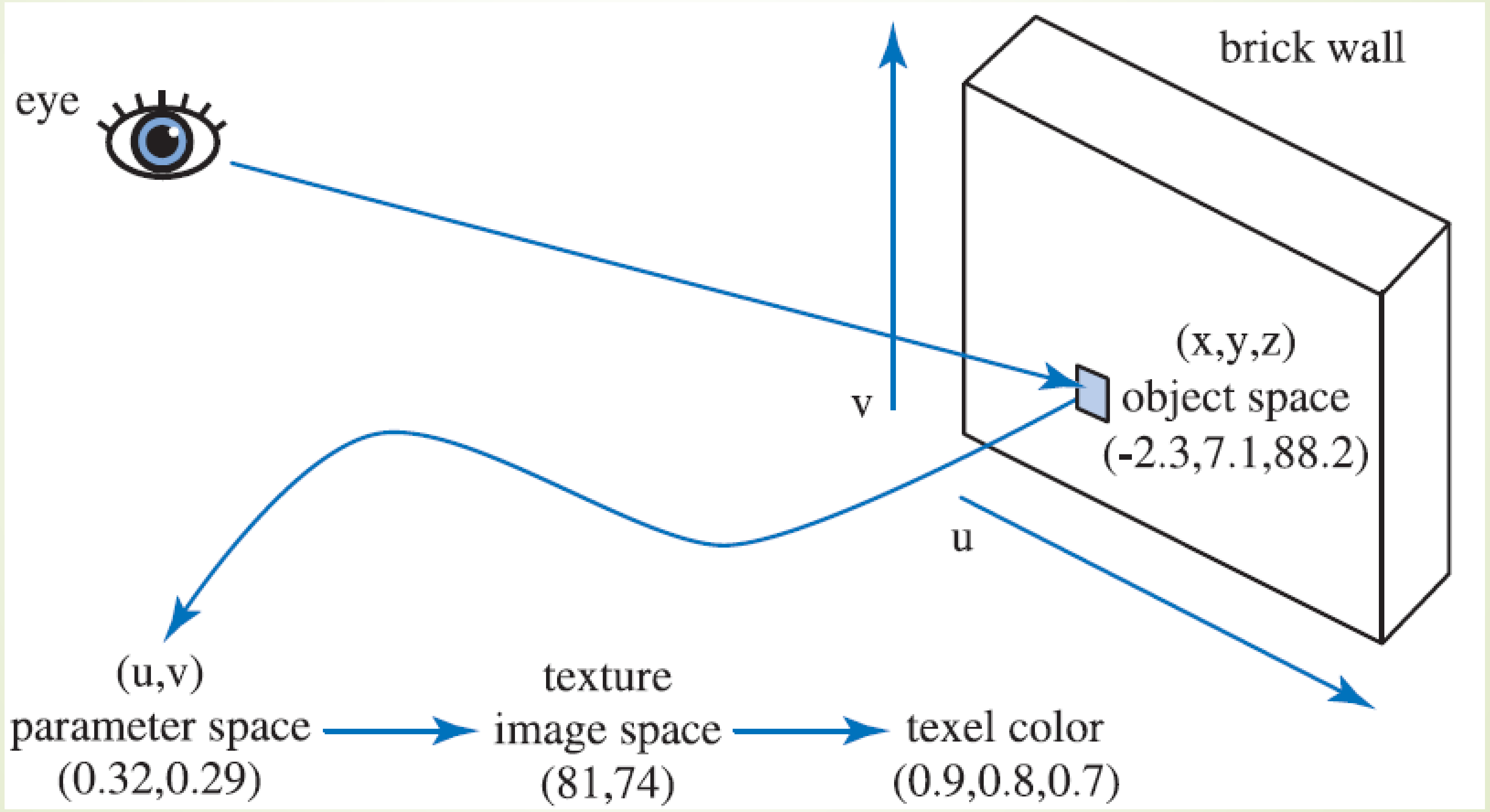


- We use triangles in real-time rendering, why?
  - Interpolation is rotation-invariant!
  - Not so for quadrilaterals.

Texture Pipeline

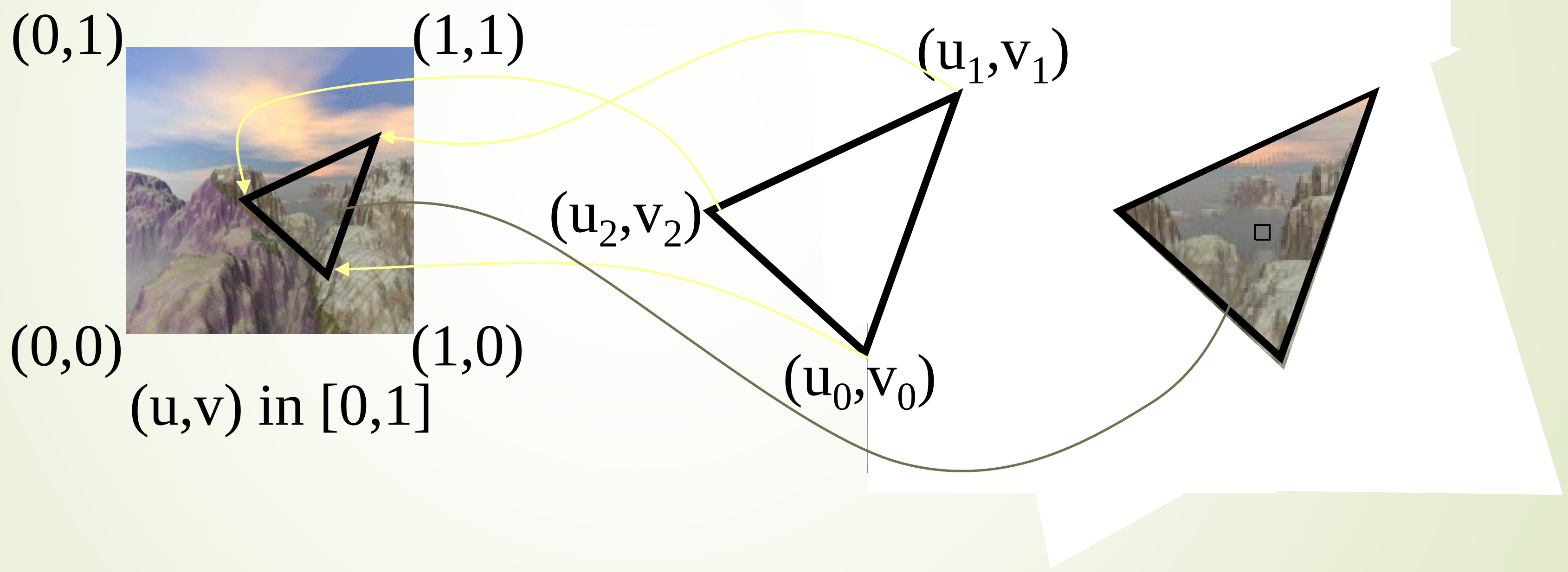


Texture Pipeline



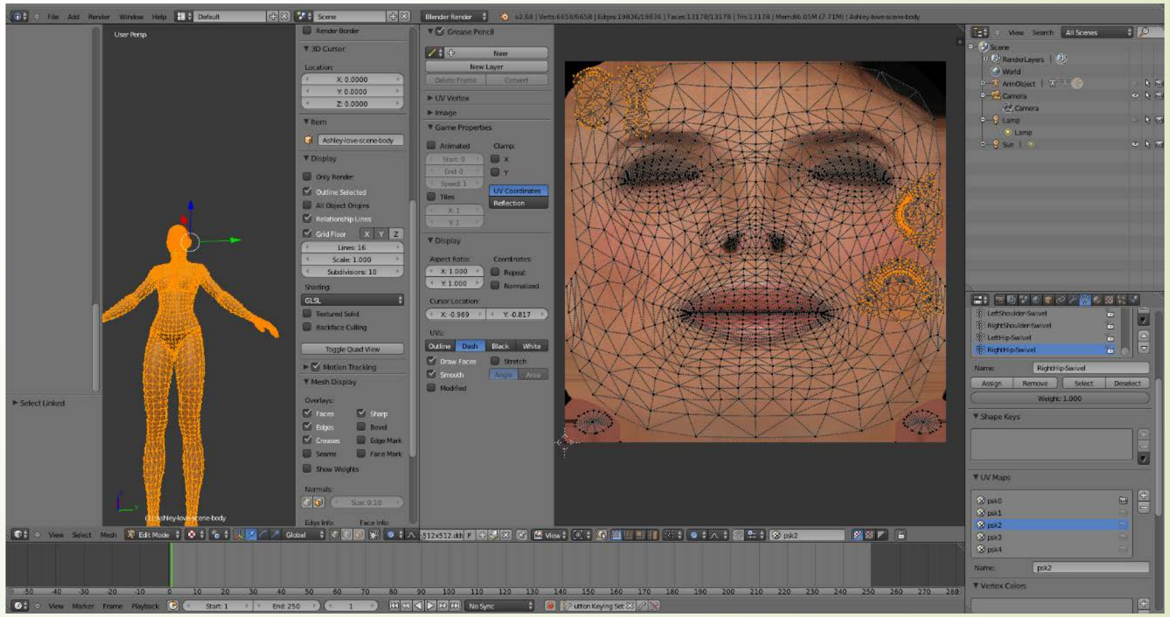
Texture coordinates

- How do you come up with these coordinates?



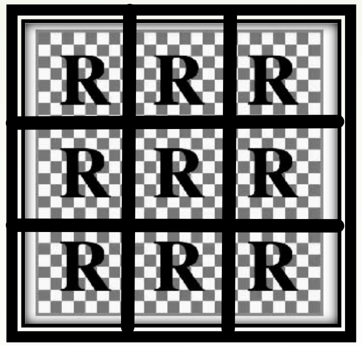
Projector Function

- Project surface point to parameter space, a.k.a. (u,v) space
- Projection is usually done automatically via
  - projector functions
  - Mesh unwarpping algorithms
- Artists can edit (u,v) coordinates (a.k.a. uv map editing)



Projector Functions

- Given an image:

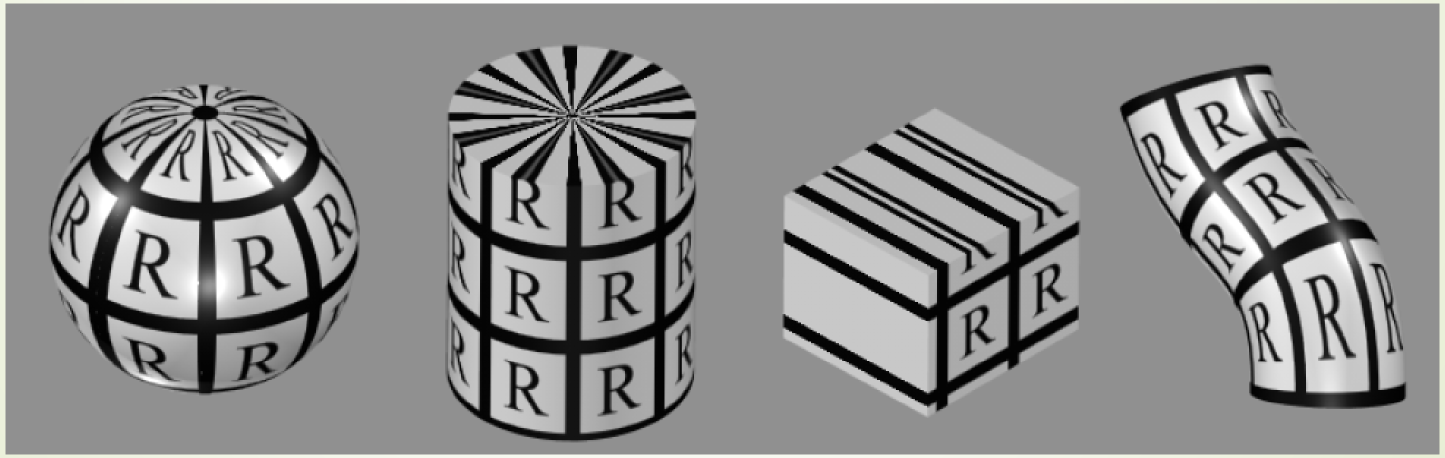


Spherical projection

Cylindrical projection

Planar projection

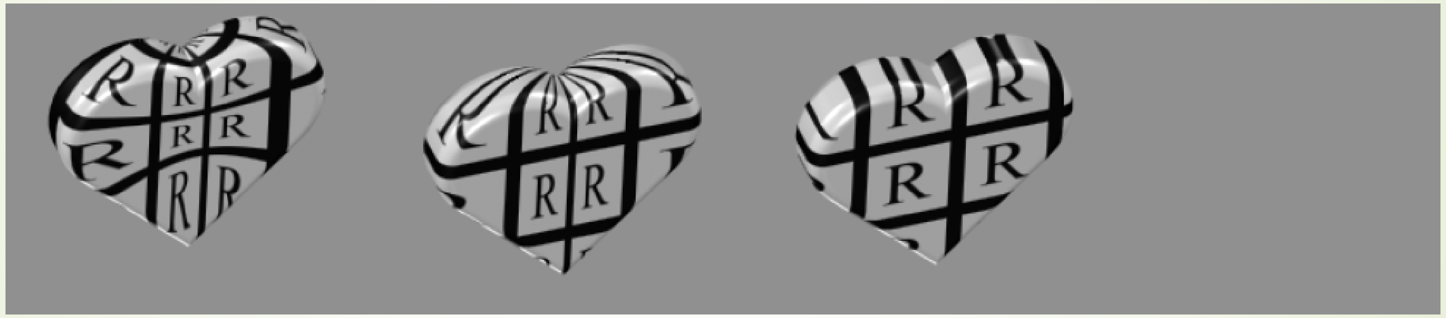
Natural projection



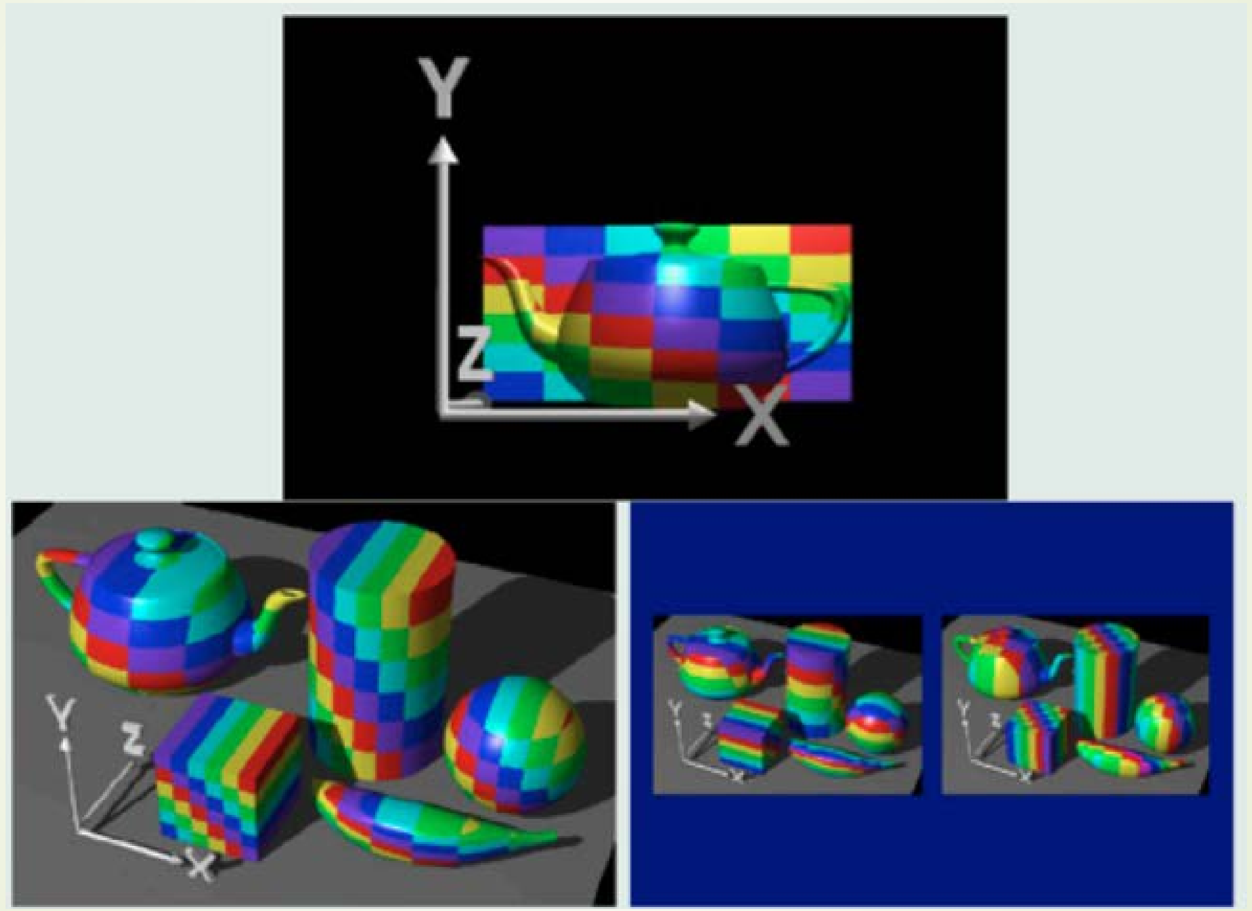
Projector Functions

- Different projections on the same shape

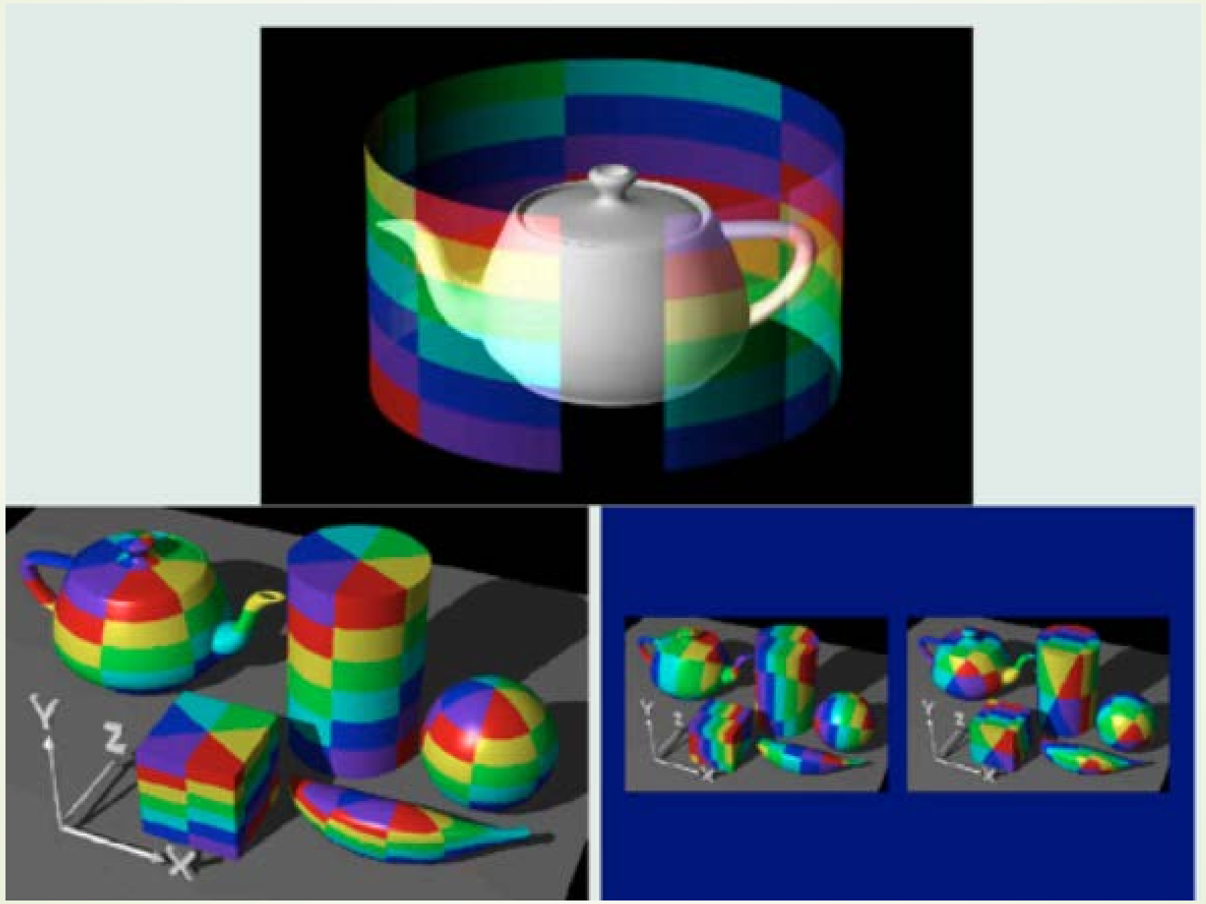
Spherical projection | Cylindrical projection | Planar projection | Natural projection



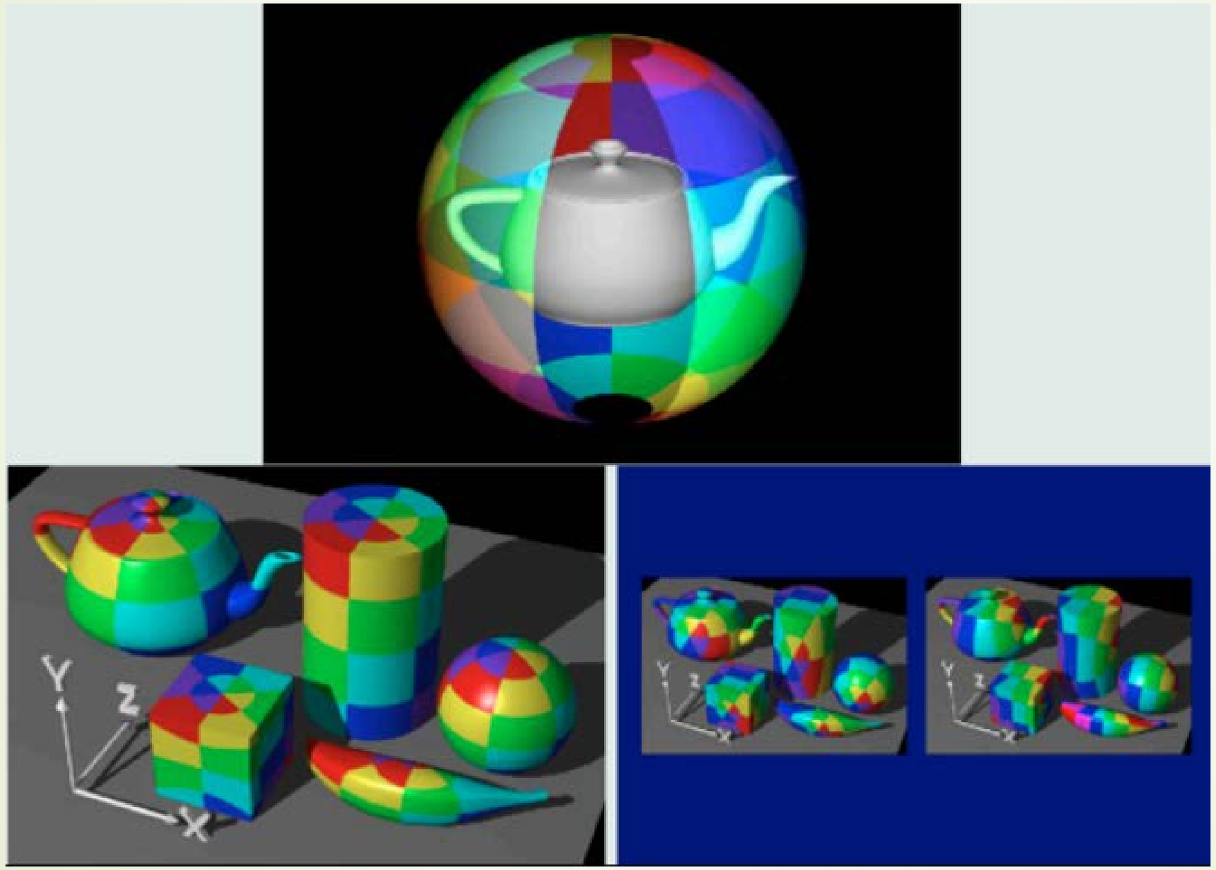
Planar



Cylindrical

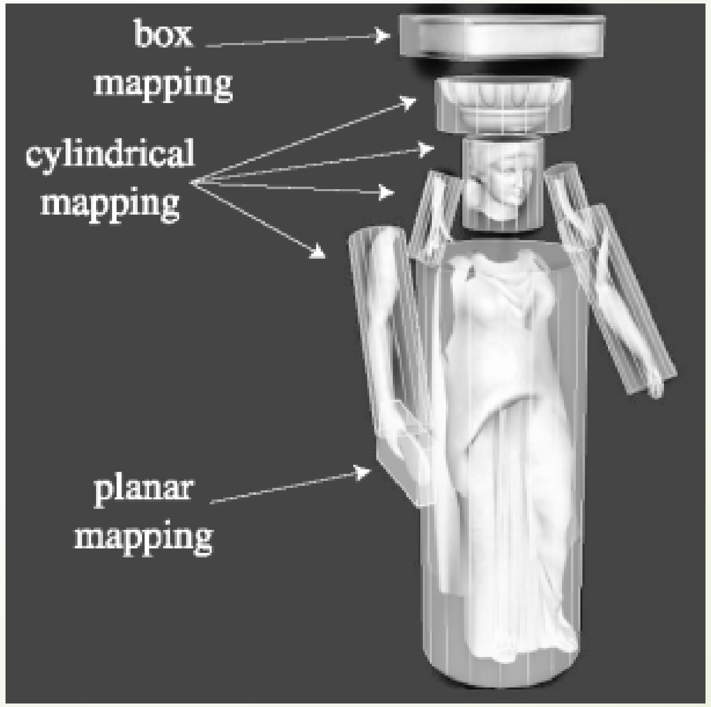


Spherical



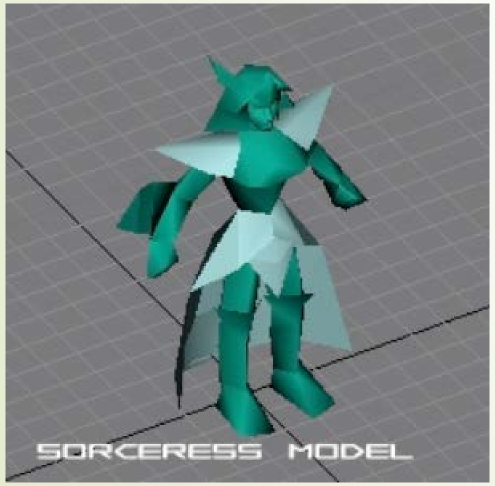
Projector Functions

- Various projector functions can be applied to the different parts of a model

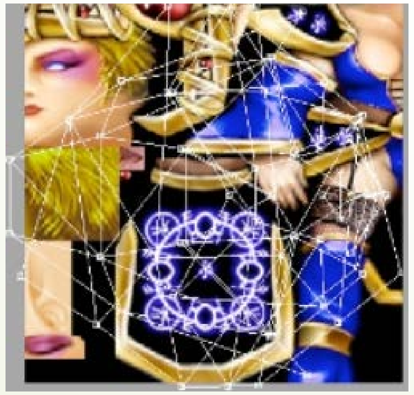
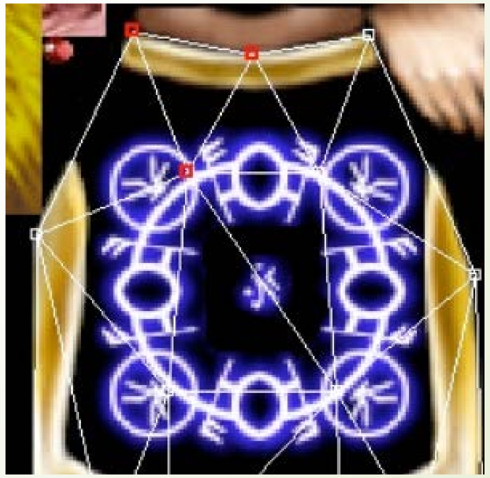


User Defined UV map

- Unwrap mesh
  - Set of planar projections
  - Minimize distortion
- Smaller textures for each of the projections
- Pack it into a larger texture

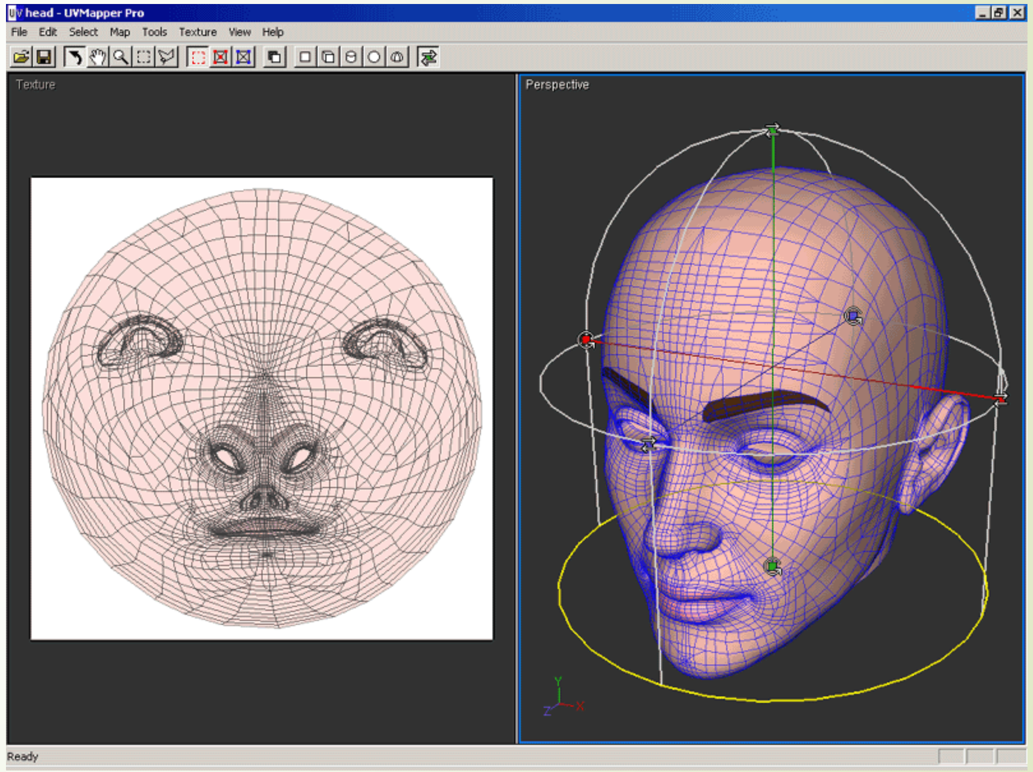


Warcraft III

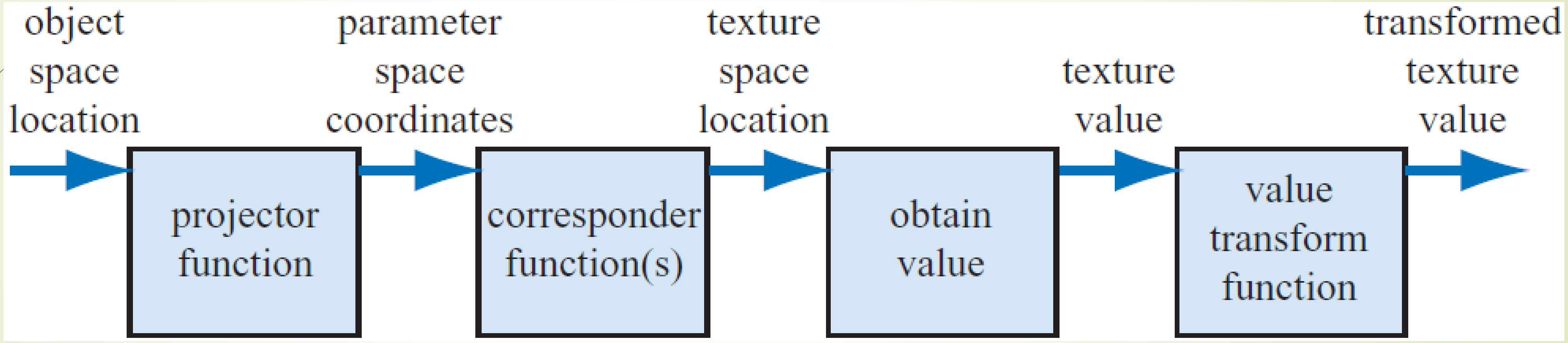



Demo: Maya

- Download student version
- Option:
  - http://www.uvmapper.com/

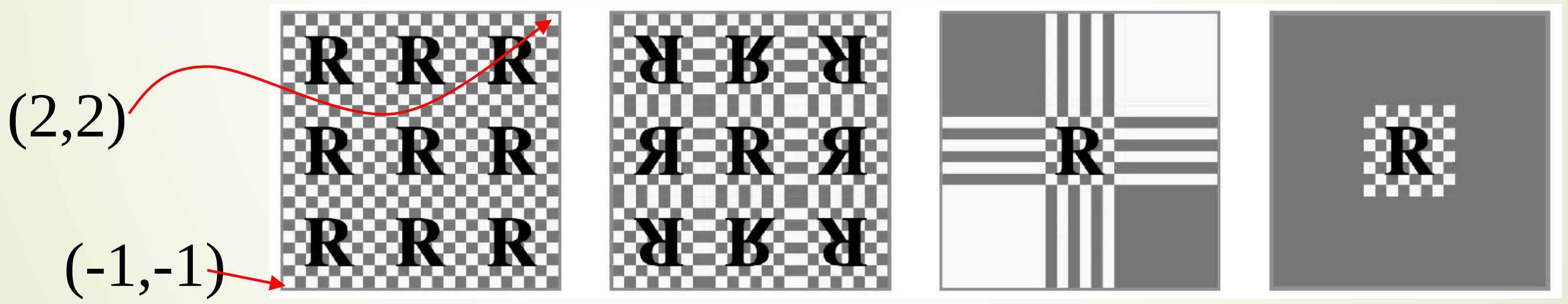


Texture Pipeline

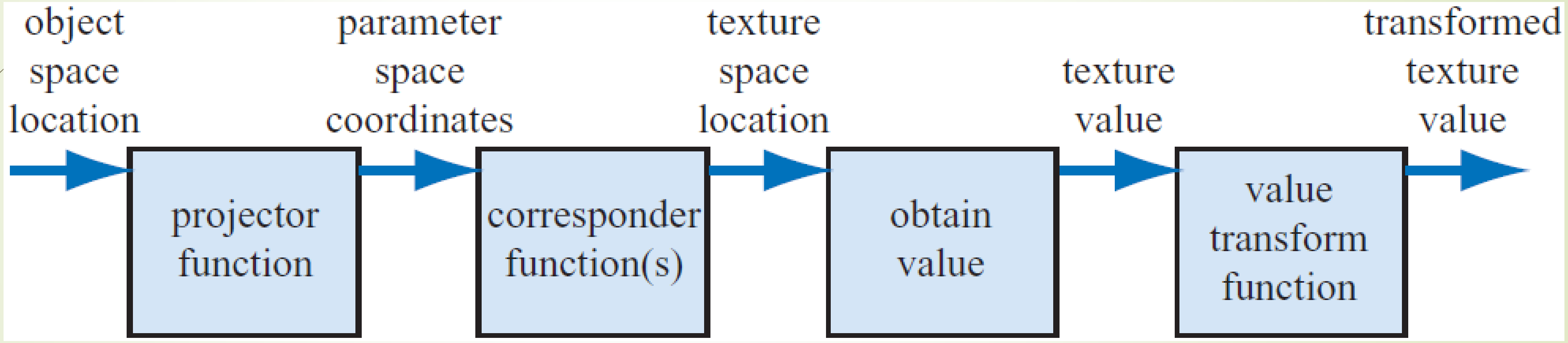


Corresponder Function

- What if (u,v) >1.0 or <0.0 ?
- To repeat textures, use just the fractional part
  - Example: 5.3 -> 0.3
- Repeat, mirror, clamp, border:

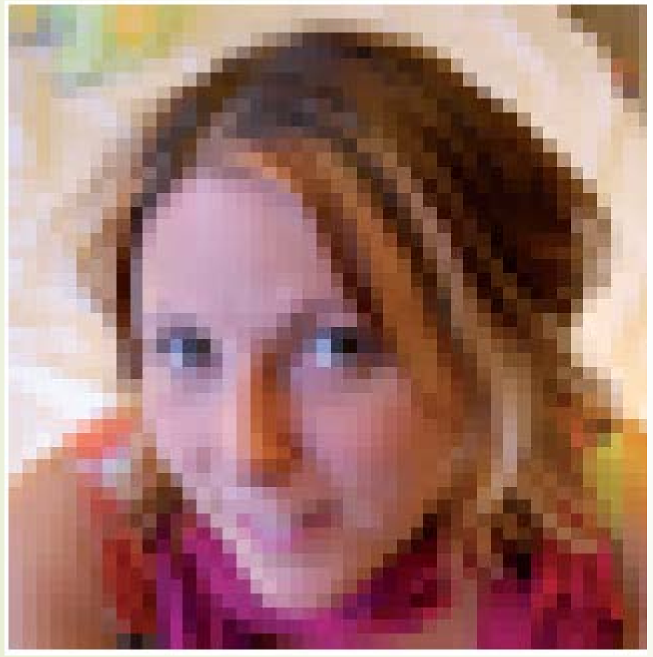


Texture Pipeline



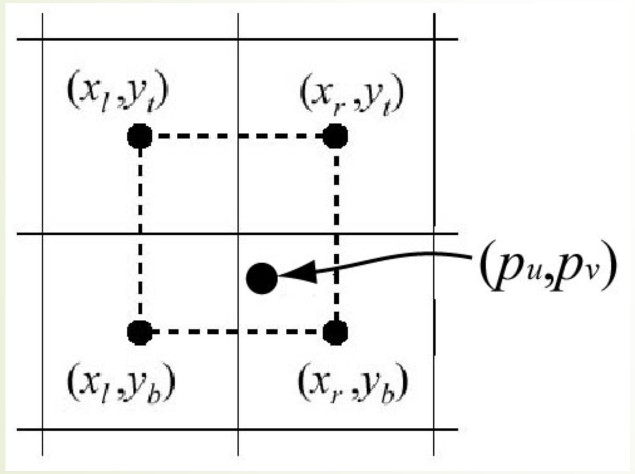
Obtain Value: Texture magnification

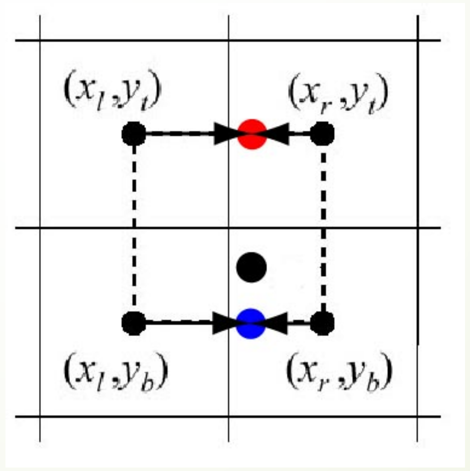
- Texture magnification of a 48x48 image ont 320x320 pixel
- Box filter (nearest-neighbor) is poor in quality

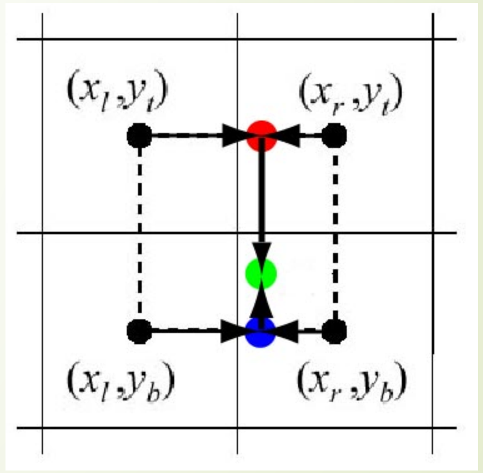


Bilinear interpolation

- Texture coordinates (p_u,p_v) in [0,1]
- Texture images size: n*m texels
- Nearest neighbor would access: (floor(n*u), floor(m*v))
- Interpolate 1D in x & y







Bilinear interpolation

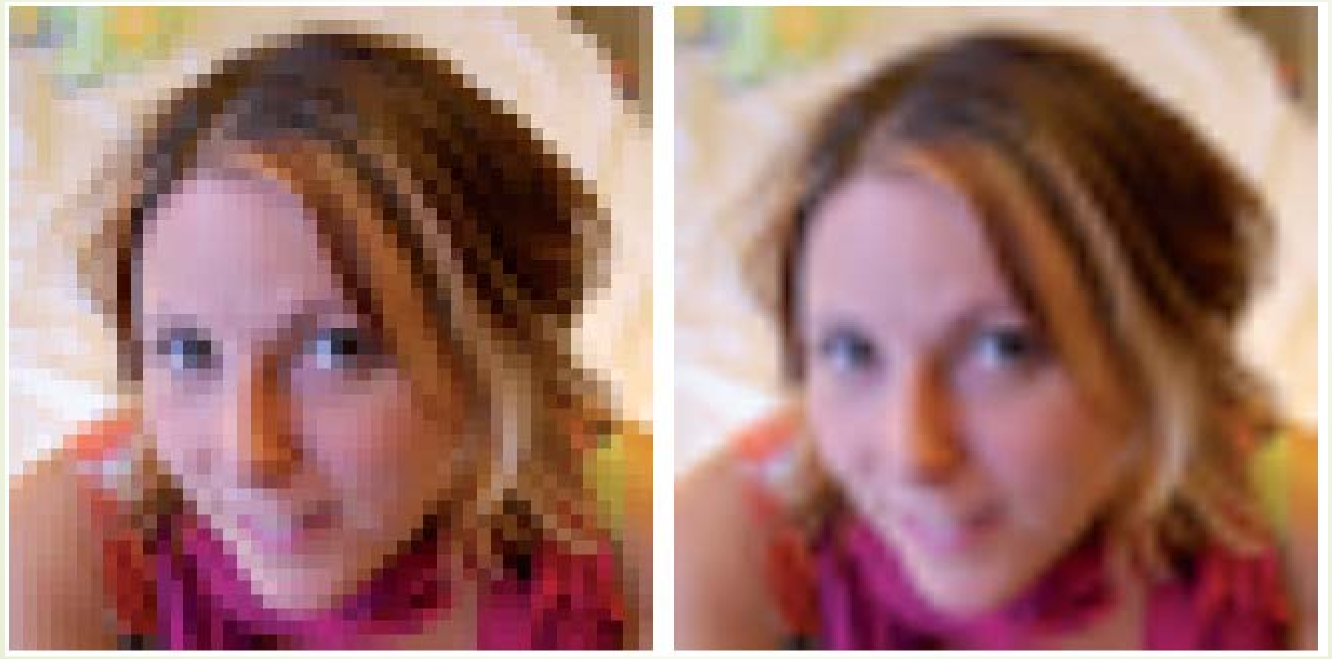
- Check out this formula at home
- $\mathbf{t}(u,v)$ accesses the texture map
- $\mathbf{b}(u,v)$ filtered texel

$$(u', v') = (p_u - \lfloor p_u \rfloor, p_v - \lfloor p_v \rfloor).$$

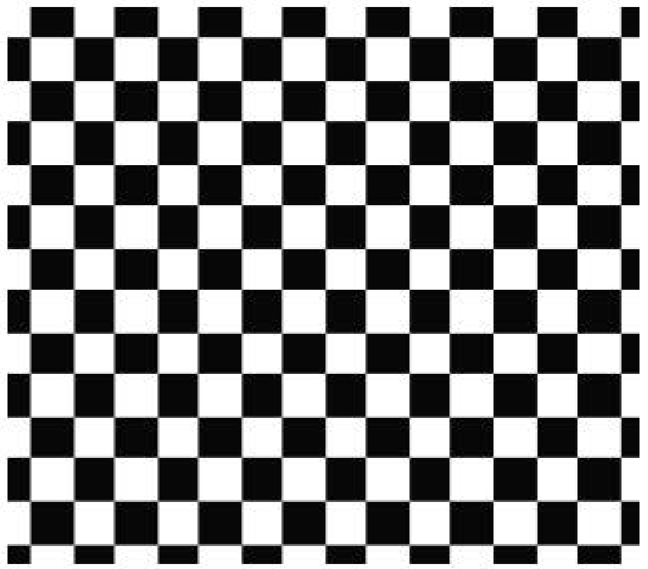
$$\begin{aligned}\mathbf{b}(p_u, p_v) =& (1-u')(1-v')\mathbf{t}(x_l, y_b) + u'(1-v')\mathbf{t}(x_r, y_b) \\ &+ (1-u')v'\mathbf{t}(x_l, y_t) + u'v'\mathbf{t}(x_r, y_t).\end{aligned}$$

Bilinear interpolation

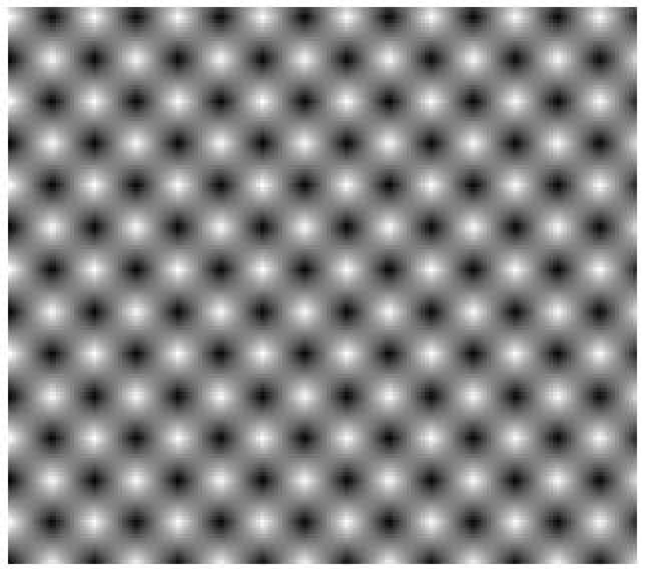
- Nearest neighbor filtering vs. Bilinear interpolation



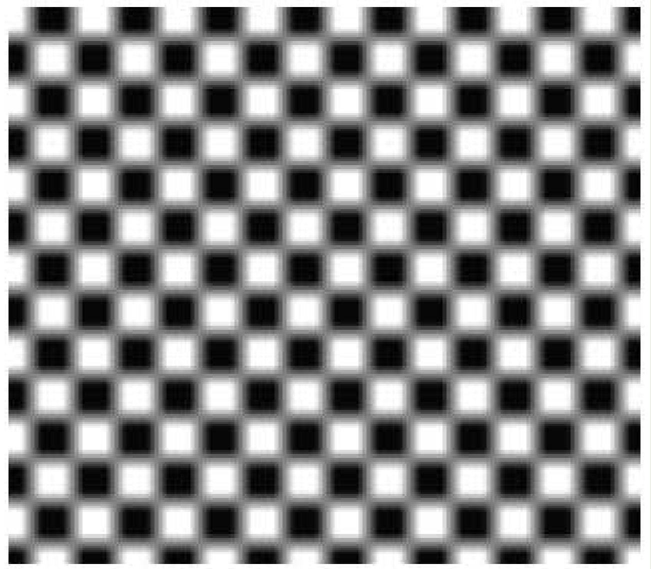
Problem with Bilinear interpolation



Nearest neighbor

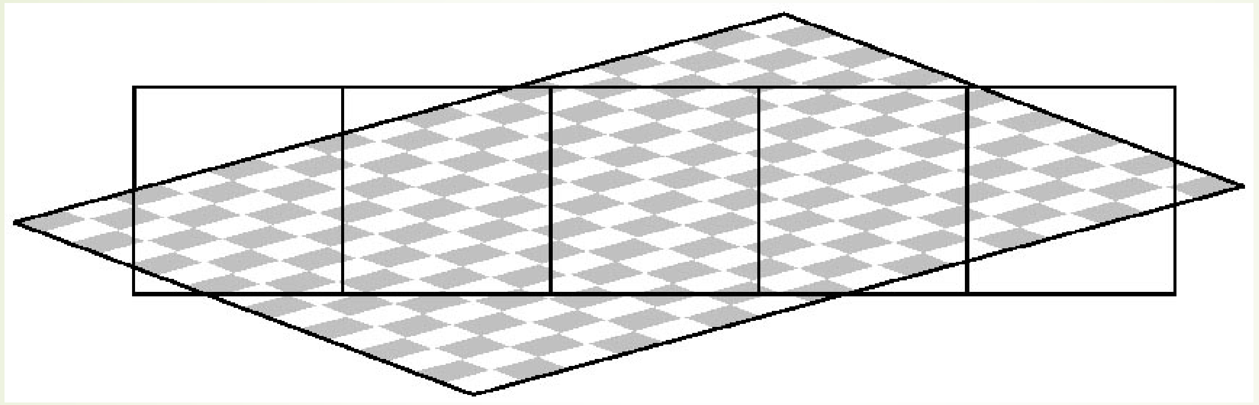


Bilinear interpolation



After remapping:
C>0.6 is white
C<0.4 is black

Texture minification
What does a pixel ”see”?



- Several texels can be covered by a single pixel
  - Nearest neighbor (using the center of the pixel)
  - Bilinear interporlation (again, using the center of the pixel)
  - Compute an average of all enclosed texels
    - Works better but can be slow

Texture minification