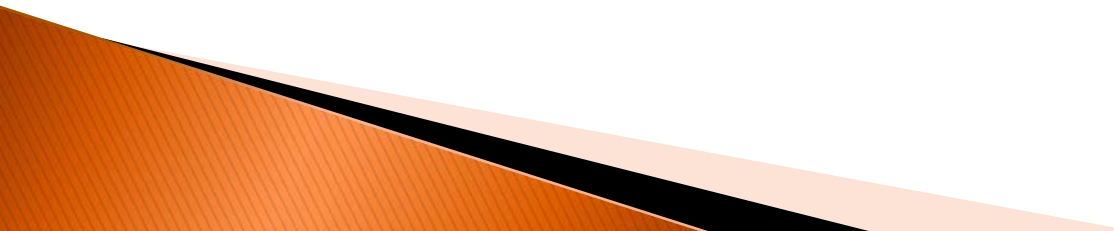


CSE 320o Micro-Computer Graphics

Texture Mapping

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Outline

- ▶ Pixel/Geometric Pipelines
 - ▶ Buffers & Mapping
 - ▶ Common Challenges
 - ▶ Texture Mapping
 - ▶ Parametric Surfaces
 - ▶ Environmental Mapping
 - ▶ Bump Mapping
 - ▶ Pros & Cons
 - ▶ Steps to implement
 - ▶ Questions?
 - ▶ Review Questions
- 

Pixel & Geometric Pipelines

- ▶ Raster-based Operations:
 - Texture Mapping
 - Anti-aliasing
 - Alpha blending
 - Compositing

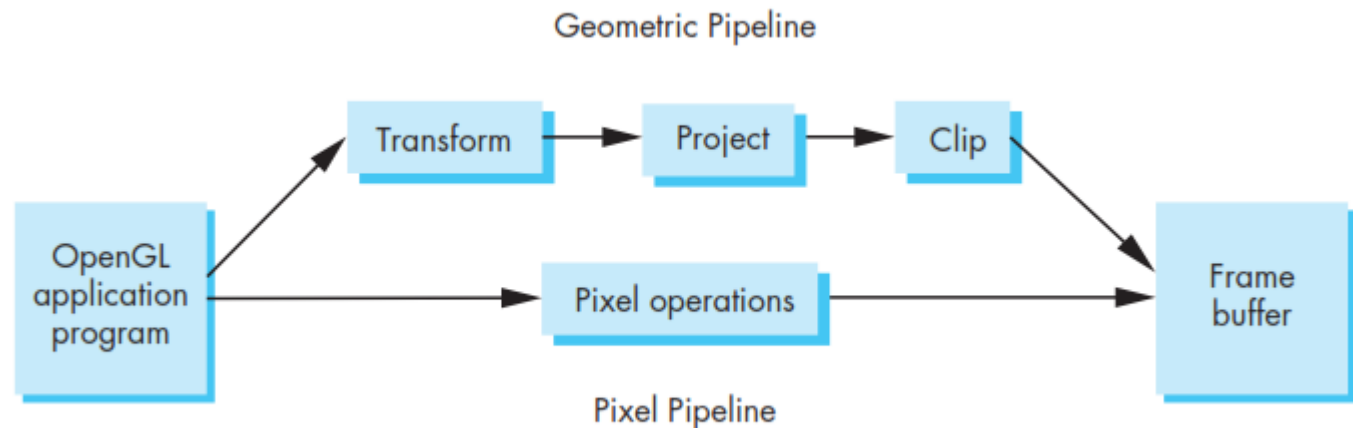


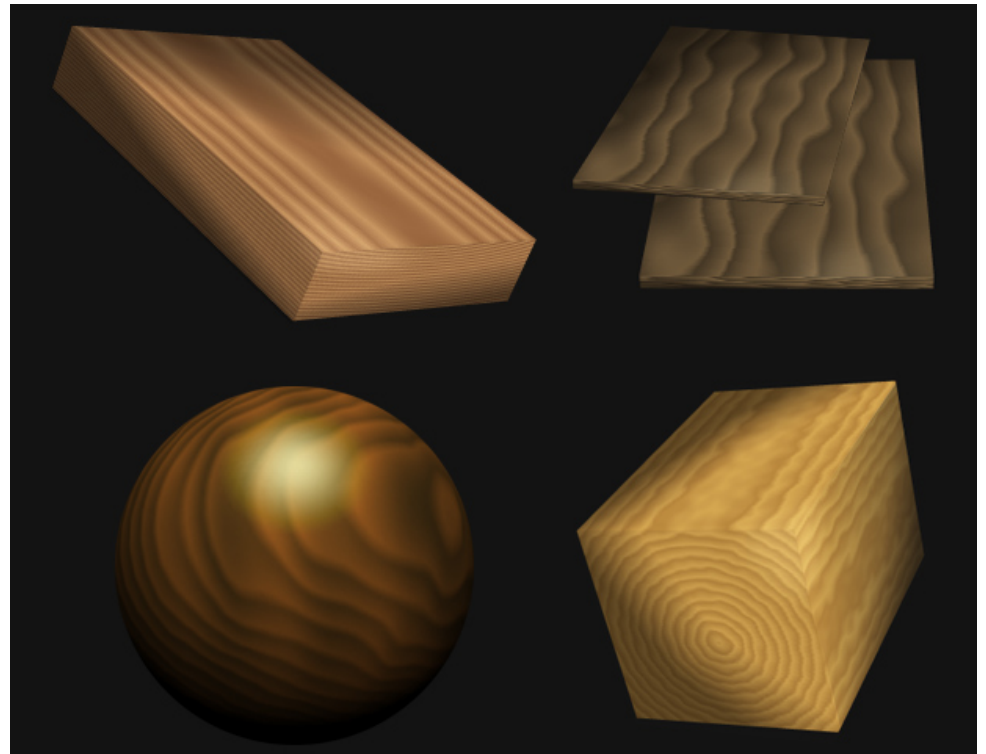
FIGURE 2.6 Simplified OpenGL pipeline.

Buffers & Mappings

- ▶ CG Buffers are blocks of memory that can be defined as $n \times m$ k -bit elements
- ▶ Numerical accuracy or **precision of a given buffer is determined by** its depth
- ▶ One of the most powerful use of buffers is for surface rendering
- ▶ Mapping algorithms can either modify the shading algorithm based on a 2D array (the map) or modify the shading by using the map to alter the surface parameters (material properties or normals)

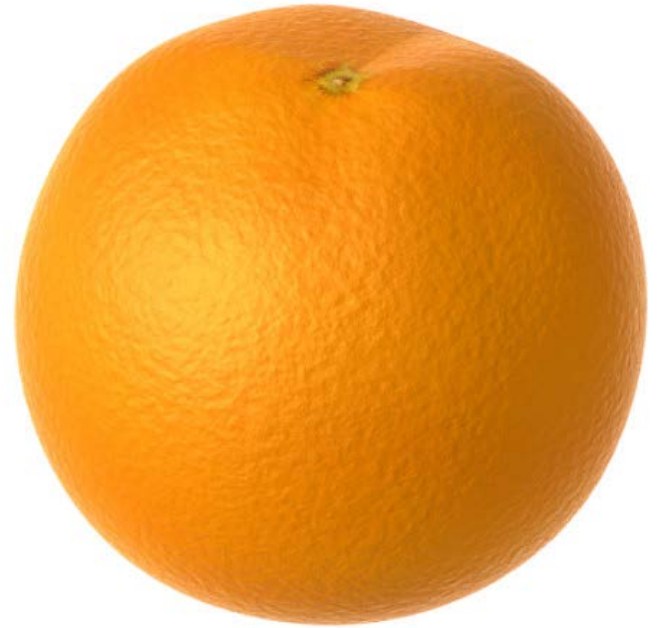
Common Challenges

- ▶ Consider the approach of creating a model of processed wood
 - TEXTURE MAPPING



Common Challenges

- ▶ Consider of an orange
 - BUMP MAPPING

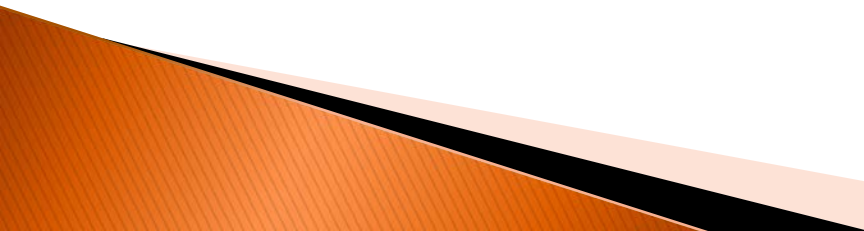


Common Challenges

- ▶ Consider creating a reflective (shiny) teapot
 - ENVIRONMENTAL MAPPING



Texture Mapping

- ▶ Patterns – stripes, checkerboards, natural materials
 - ▶ Fixed pattern, procedural texture, digitized image
 - ▶ Determines the color of a fragment
 - ▶ Fragments are small pieces of a surface – each is at most the size of one pixel
 - ▶ Mapping a texture to the surface (the process)
- 

2 Dimensional Texture Mapping

- ▶ Starting point for 2-dimensional texture pattern – $T(s,t)$, where s and t are texture independent texture coordinates
- ▶ T is stored in texture memory as a $n \times m$ array – texels
- ▶ A **Texture map** associates a unique point of T with a point on a geometric object and is mapped to screen coordinates for display

Recall the pixel/vector Pipelines

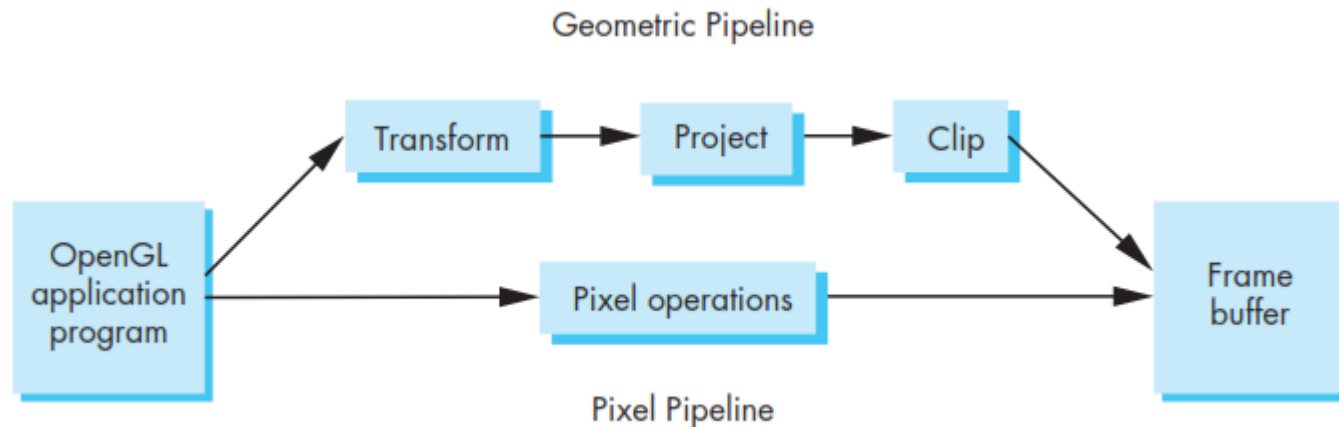


FIGURE 2.6 Simplified OpenGL pipeline.

2 Dimensional Texture Mapping

- ▶ We can think in terms of a mathematical function that maps from texture coordinates to geometric coordinates and a projection function that maps from geometric coordinates to screen coordinates
- ▶ $TCo > mf > GCo > pf > SCo$

Parametric Surfaces

- ▶ Surface
- ▶ 2 coordinates
- ▶ Parametric
- Coordinate
- Geometry
- coordinates
- ▶ (PC)

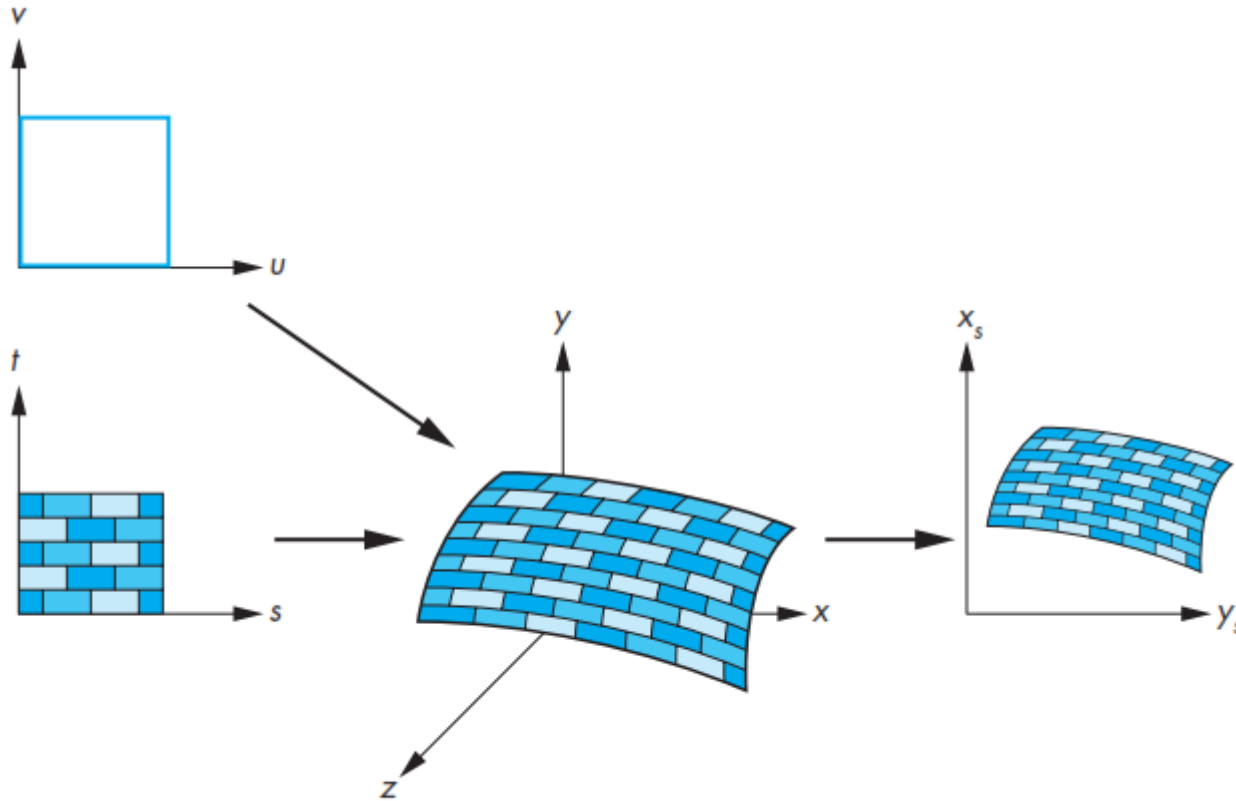


FIGURE 7.9 Texture maps for a parametric surface.

Texture Mapping – simplicity

- ▶ We can assume that the values of T are RGB color values
- ▶ We can either modify the color of the surface by these values or replace the surface color based on the texture
- ▶ Color assignment is carried out as part of the shading calculations

Complex Texture Mapping

- ▶ Mapping a rectangular texture onto a curved surface – texture distortion
 - Mapping on to a sphere



Environmental or Reflection Maps

- ▶ Surfaces with specular reflections that mirror the environment
- ▶ The effects can be produced by a ray tracer but too time consuming
- ▶ We instead get an image that approximates the environment and texture map it onto the surface
 - Pros /Cons???

Bump Mapping

- ▶ We can take an image of a real orange and map onto a sphere
- ▶ But if the object is moved or the light is moved we will notice that surface is unusually smooth
- ▶ We instead can use bump mapping techniques to vary the apparent shape of the surface by perturbing the normal vectors

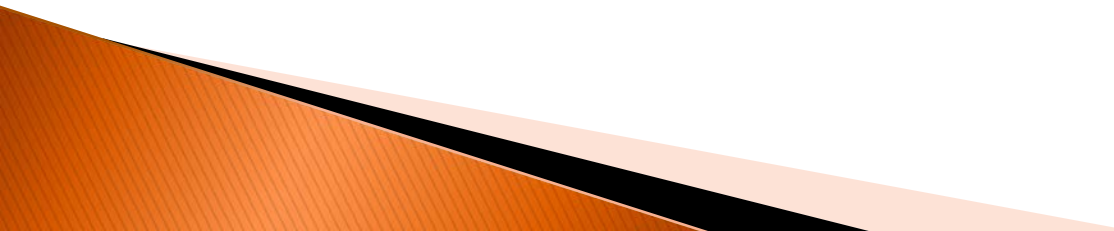
Pros & Cons

- ▶ The advantage is complexity reduction and rendering speed, because only one texel read is required for each pixel being written to the frame buffer
- ▶ The disadvantage is the blocky image that results when the object moves
- ▶ Aliased artifacts

Steps in Texture Mapping (OpenGL)

- ▶ *Create a texture object and specify a texture for that object*
- ▶ *Indicate how the texture is to be applied to each pixel*
 - decal mode, in which the texture is painted on top of the fragment, just as a decal would be applied
 - The replace mode, a variant of the decal mode
 - Another method is to use the texture to modulate, or scale, the fragment's color; this technique is useful for combining the effects of lighting with texturing
 - a constant color can be blended with that of the fragment, based on the texture value (transparency)
- ▶ *Enable texture mapping.*
glEnable() with the symbolic constant GL_TEXTURE_2D
- ▶ *Draw the scene, supplying both texture and geometric coordinates*

Review

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- 

Questions?

Resources

- ▶ Interactive computer graphics: a top down approach with OpenGL / Edward Angel. ISBN: 0-201-38597-X
- ▶ <http://radoff.com/blog/2008/08/22/anatomy-of-an-mmorpg>