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Texture Mapping

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Textures

- Describe color variation in interior of 3D polygon
 - When scan converting a polygon, vary pixel colors according to values fetched from a texture

Angel Figure 9.3

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3D Rendering Pipeline (for direct illumination)

3D Primitives → 3D Modeling Coordinates

Modeling Transformation → 3D World Coordinates

Lighting → 3D World Coordinates

Viewing Transformation → 3D Camera Coordinates

Projection Transformation → 2D Screen Coordinates

Clipping → 2D Screen Coordinates

Viewport Transformation → 2D Image Coordinates

Scan Conversion → 2D Image Coordinates


Image

Texture mapping


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Surface Textures

- Add visual detail to surfaces of 3D objects



Polygonal model

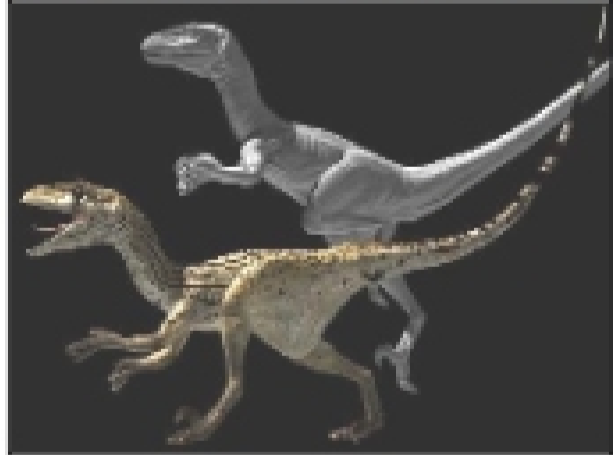



With surface texture

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Surface Textures

- Add visual detail to surfaces of 3D objects

[Daren Horley]

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Overview

- Texture mapping methods
 - Parameterization
 - Mapping
 - Filtering
- Texture mapping applications
 - Modulation textures
 - Illumination mapping
 - Bump mapping
 - Environment mapping
 - Image-based rendering
 - Non-photorealistic rendering

Parameterization 7

geometry + image = texture map

- Q: How do we decide *where* on the geometry each color from the image should go?

Option: Varieties of projections 8

[Paul Bourke]

Option: unfold the surface 9

[Piponi2000]

Option: make an atlas 10

charts atlas surface

[Sander2001]

Overview 11

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Texture Mapping 12

- Steps:
 - Define texture
 - Specify mapping from texture to surface
 - Lookup texture values during scan conversion

Texture Coordinate System Modeling Coordinate System Image Coordinate System

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Texture Mapping

- When scan convert, map from ...
 - image coordinate system (x,y) to
 - modeling coordinate system (u,v) to
 - texture image (t,s)

The diagram illustrates the mapping process in three stages:

- Texture Coordinate System:** A 2D grid with axes s and t . A red square is highlighted within the grid.
- Modeling Coordinate System:** A 3D cube with axes u and v . The corners are labeled with coordinates $(0,0)$, $(1,0)$, $(0,1)$, and $(1,1)$. A red square is mapped onto the front face of the cube.
- Image Coordinate System:** A 2D grid with axes x and y . A red square is mapped onto the grid, representing the final scan-converted image.

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Texture Mapping

- Texture mapping is a 2D projective transformation
 - texture coordinate system: (t,s) to
 - image coordinate system (x,y)

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Texture Mapping

- Scan conversion
 - Interpolate texture coordinates down/across scan lines
 - Distortion due to bilinear interpolation approximation
 - Cut polygons into smaller ones, or
 - Perspective divide at each pixel

The diagram shows a triangle on a grid. The vertices are labeled with texture coordinates: (u_1, v_1) at the top, (u_2, v_2) at the right, and (u_3, v_3) at the bottom. A scan line is drawn across the triangle, and the texture coordinates at the intersection points are labeled cc , u , and v .

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Texture Mapping

Two diagrams compare interpolation methods for a textured quadrilateral:

- Linear interpolation of texture coordinates:** Shows a grid of pixels that is distorted, appearing skewed and non-uniform in density.
- Correct interpolation with perspective divide:** Shows a grid of pixels that is correctly rendered, appearing uniform and undistorted.

IBM Figure 8.42

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Texture Filtering

- Must sample texture to determine color at each pixel in image