Texture Mapping

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Introduction

- **Texture :**A detailed pattern that is repeated many times to tile the plane.
- **Texture Mapping:** a technique of defining surface properties (especially shading parameters) in such a way that they vary as a function of position on the surface.
- Texture mapping is a powerful technique for adding realism to a computer-generated scene.

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Three Types of Mapping

- Texture Mapping
  - Uses images to fill inside of polygons
- Environment (reflection mapping)
  - Uses a picture of the environment for texture maps
  - Allows simulation of highly specular surfaces
- Bump mapping
  - Bump mapping is a technique in computer graphics for simulating bumps and wrinkles on the surface of an object.

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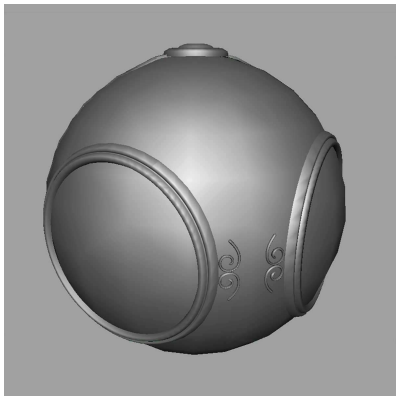
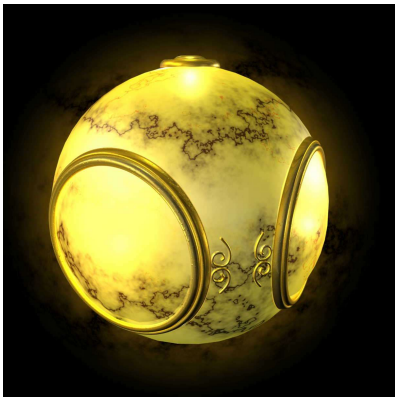
Texture Mapping



geometric model



texture mapped

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Environment Mapping

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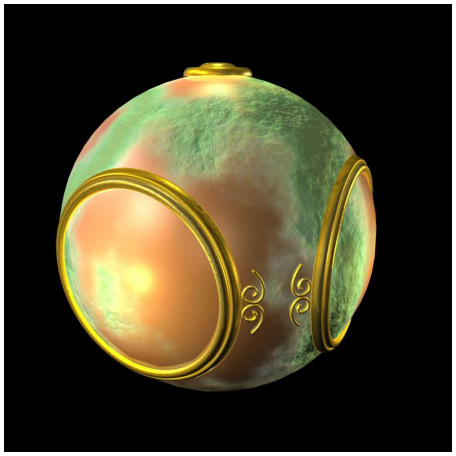
Bump Mapping



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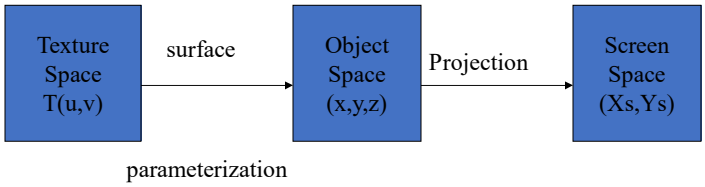
How is texture mapping done

Two Dimensional Texture Mapping ::



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Types of Texture Mapping

- Two Types
  1. Forward texture mapping

     computing 3D positions of the texture points and then projecting them onto the image plane.
  2. Inverse texture mapping

     selecting every pixel in the image plane and finding what point of the texture plane is projected there.

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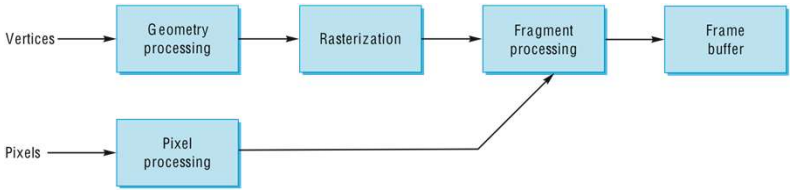
Where does mapping take place?

- Mapping techniques are implemented at the end of the rendering pipeline
  - Very efficient because few polygons make it past the clipper



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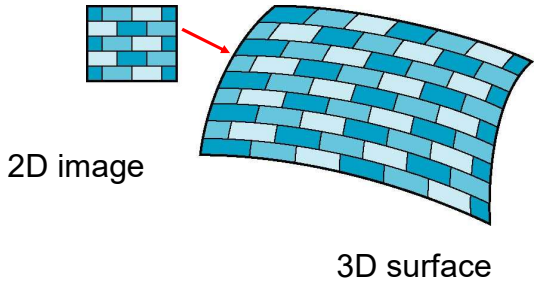
Is it simple?

- Although the idea is simple---map an image to a surface---there are 3 or 4 coordinate systems involved



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Coordinate Systems

- Parametric coordinates
  - May be used to model curves and surfaces
- Texture coordinates
  - Used to identify points in the image to be mapped
- Object or World Coordinates
  - Conceptually, where the mapping takes place
- Window Coordinates
  - Where the final image is really produced

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Algorithm

- The Algorithm divides the surface patch in object space.
- At the same time , executes subdivision in texture space.
- Patch subdivision proceeds until it ends in single pixel.
- After it reached this point, Subdivision process terminates .
- The required texture value for each pixel is obtained from texture domain.

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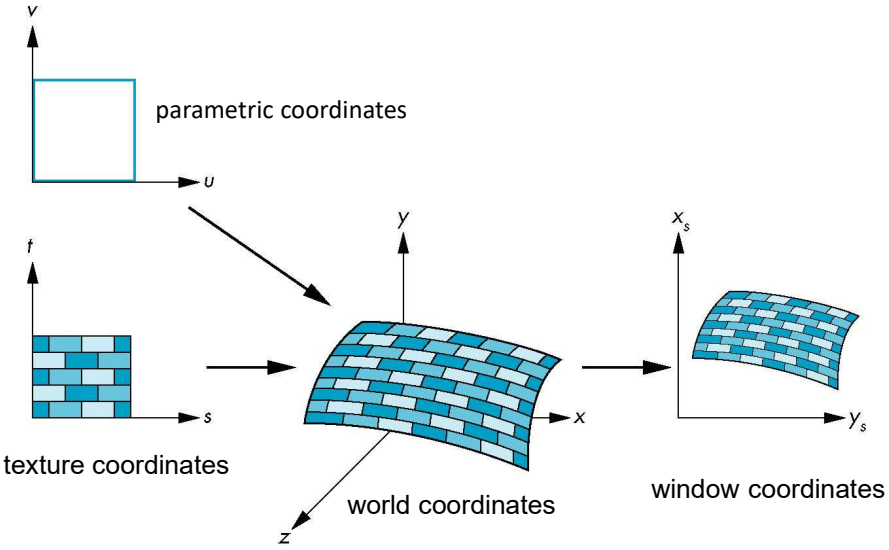
Texture Mapping



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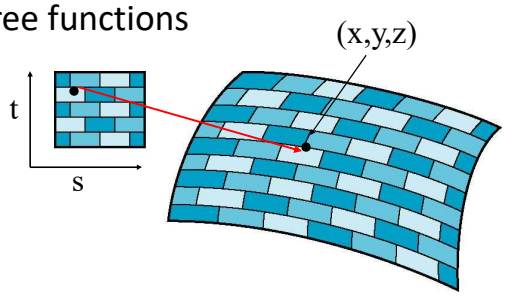
Mapping Functions

- Basic problem is how to find the maps
- Consider mapping from texture coordinates to a point a surface
- Appear to need three functions

$$x = x(s,t)$$
$$y = y(s,t)$$
$$z = z(s,t)$$



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Backward Mapping

- We really want to go backwards
  - Given a pixel, we want to know to which point on an object it corresponds
  - Given a point on an object, we want to know to which point in the texture it corresponds
- Need a map of the form

  $s = s(x,y,z)$

  $t = t(x,y,z)$
- Such functions are difficult to find in general

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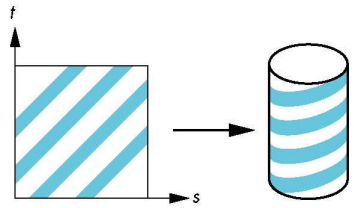
Two-part mapping

- One solution to the mapping problem is to first map the texture to a simple intermediate surface
- Example: map to cylinder



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Cylindrical Mapping

parametric cylinder

$$x = r \cos 2\pi u$$
$$y = r \sin 2\pi u$$
$$z = v/h$$

maps rectangle in u,v space to cylinder of radius r and height h in world coordinates

$$s = u$$
$$t = v$$

maps from texture space

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Spherical Map

We can use a parametric sphere

$$x = r \cos 2\pi u$$
$$y = r \sin 2\pi u \cos 2\pi v$$
$$z = r \sin 2\pi u \sin 2\pi v$$

in a similar manner to the cylinder but have to decide where to put the distortion

Spheres are used in environmental maps

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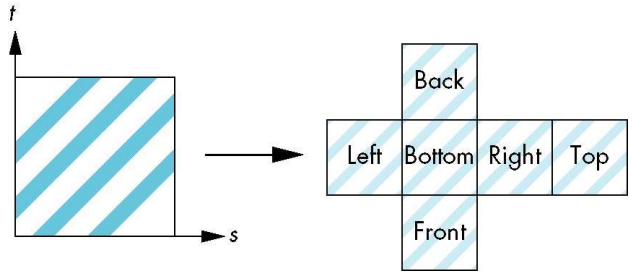
Box Mapping

- Easy to use with simple orthographic projection
- Also used in environment maps



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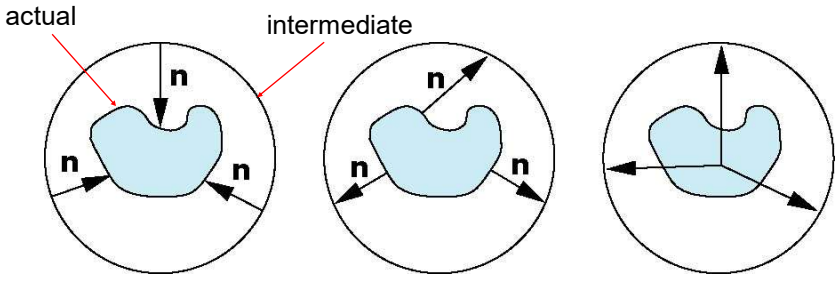
Second Mapping

- Map from intermediate object to actual object
  - Normals from intermediate to actual
  - Normals from actual to intermediate
  - Vectors from center of intermediate



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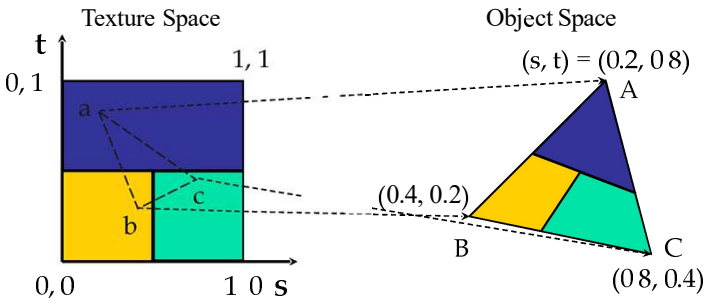
Mapping a Texture



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Bump Mapping

- Consider the problem of modeling an orange (the fruit)
- Start with an orange-colored sphere
  - Too simple
- Replace sphere with a more complex shape
  - Does not capture surface characteristics (small dimples)
  - Takes too many polygons to model all the dimples

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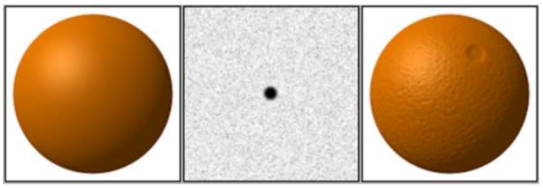
Modeling an Orange

- Take a picture of a real orange, scan it, and “paste” onto simple geometric model
  - This process is known as texture mapping
- Still might not be sufficient because resulting surface will be smooth
  - Need to change local shape
  - Bump mapping



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Drawback of Texture Mapping

- Major draw back is the image quality . Usually for high quality images Ray Tracing is used .

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