Surface Detail

- **Issues in modeling the surface of an object**

  - We must consider

    Shape

    Color

    Detail (texture)

    Randomness

  - One way to solve the problem

    Model the orange as a sphere using "subdivision"

    Combine color with shading to render the triangles

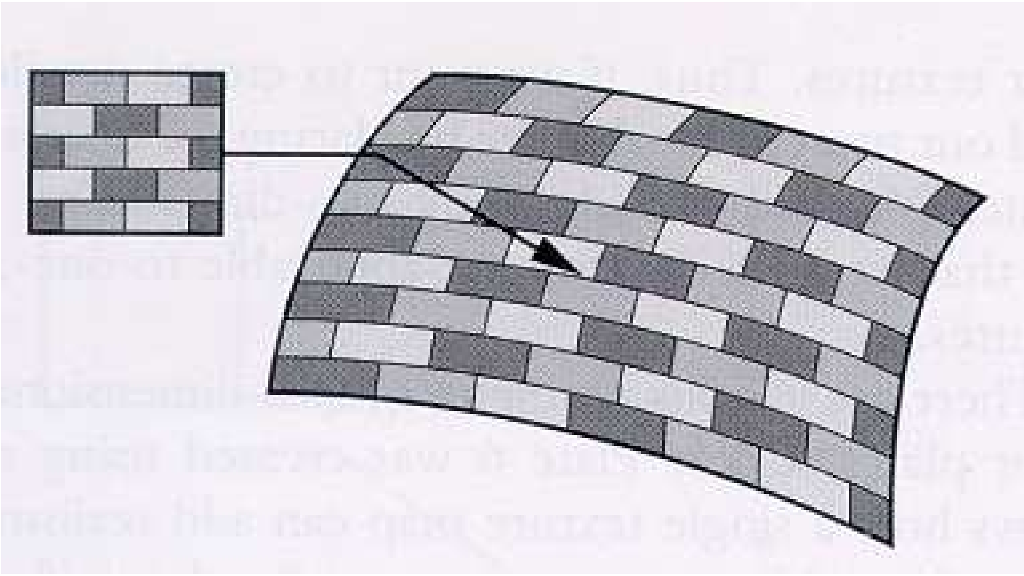
  - A better way !!!

    Texture mapping

    Bump maps

- **Texture mapping**

  - "Paint" the surface of an object using a texture pattern



- **Texture generation**

  - Generate "objects" that look like texture (time consuming !!)

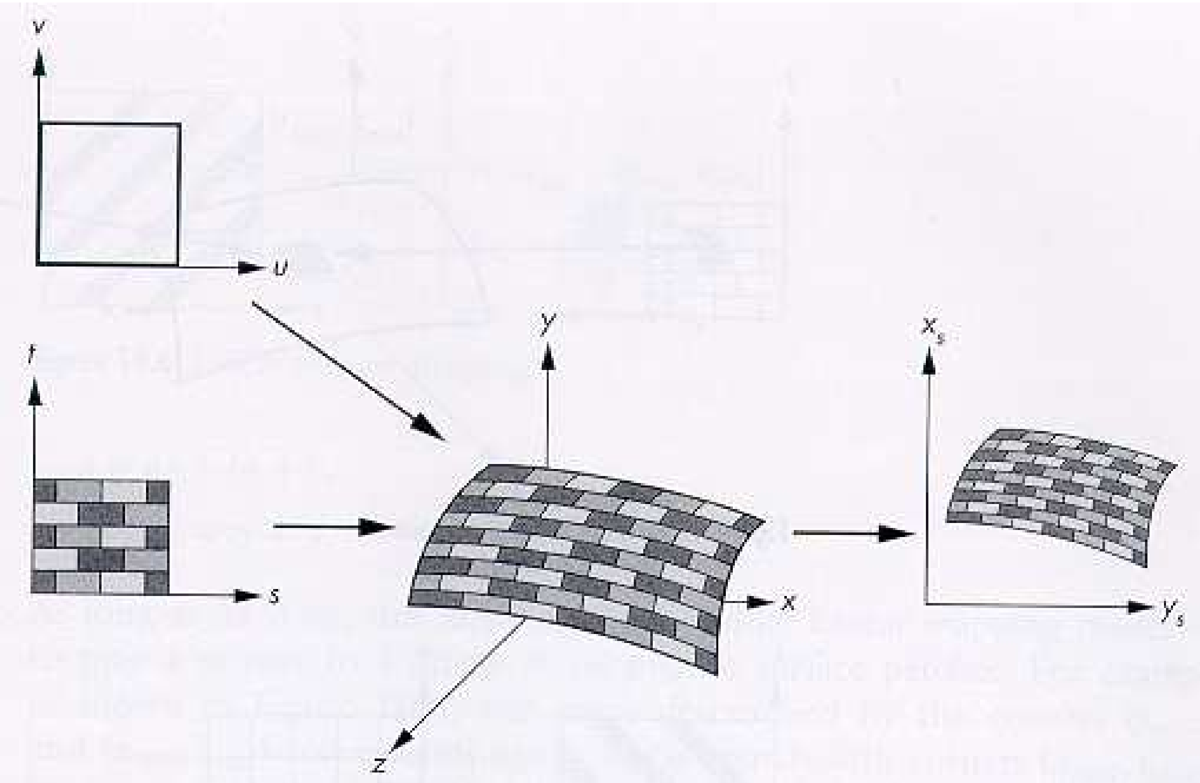
  - Use digitized images !!

- **Steps in texture mapping**

  1. Represent texture pattern as a 2D image $T(s, t)$

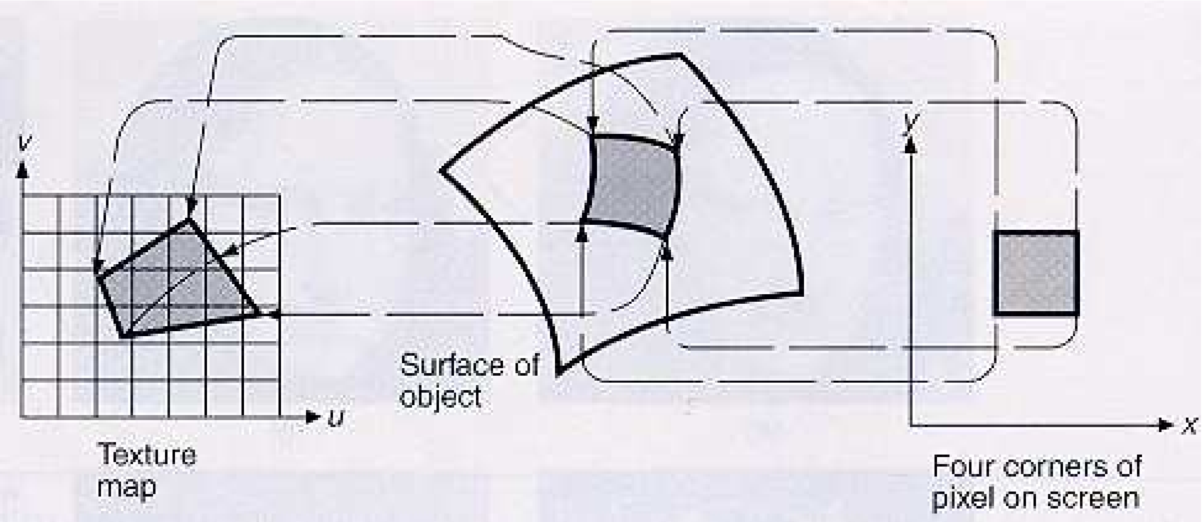
  2. Determine the mapping from texture coordinates to object coordinates (**texture map**)

  3. Apply the mapping from object coordinates to screen coordinates



- **Inverse mapping**

  - In practice, a small area of the texture pattern maps to the area of the geometric surface, corresponding to a pixel in the final image

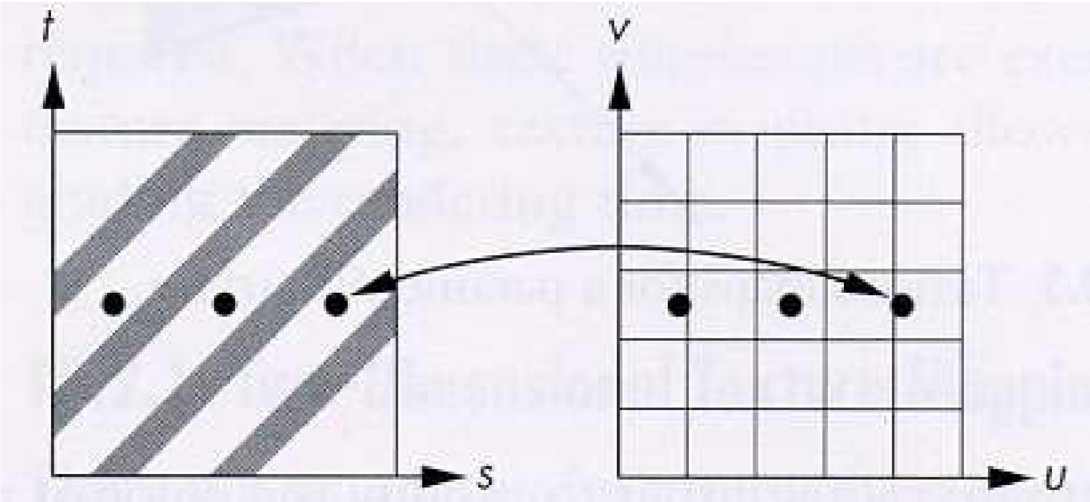


- **Practical issues**

  - The mapping from texture coordinates to object coordinates may be a complex function

    Example: map a rectangle to a sphere !!

  - Aliasing problems (artifacts)

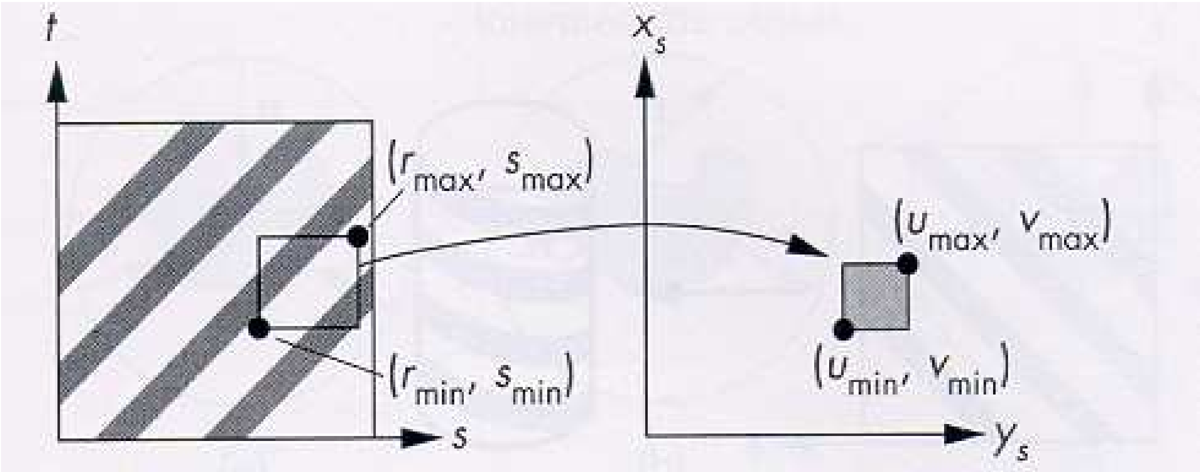


- **Linear texture mapping**

  - It does not take into account the curvature of the surface

$$u = u_{min} + (\frac{s - s_{min}}{s_{max} - s_{min}})(u_{max} - u_{min})$$

$$v = v_{min} + (\frac{t - t_{min}}{t_{max} - t_{min}})(v_{max} - v_{min})$$



- **A two-step texture mapping approach**

  - Steps

    1. Map the texture to a simple 3D intermediate surface (e.g, sphere, cylinder, cube)

    2. Map the intermediate surface to the surface being rendered

  - Examples (step 1)

Parametric representation of cylinder

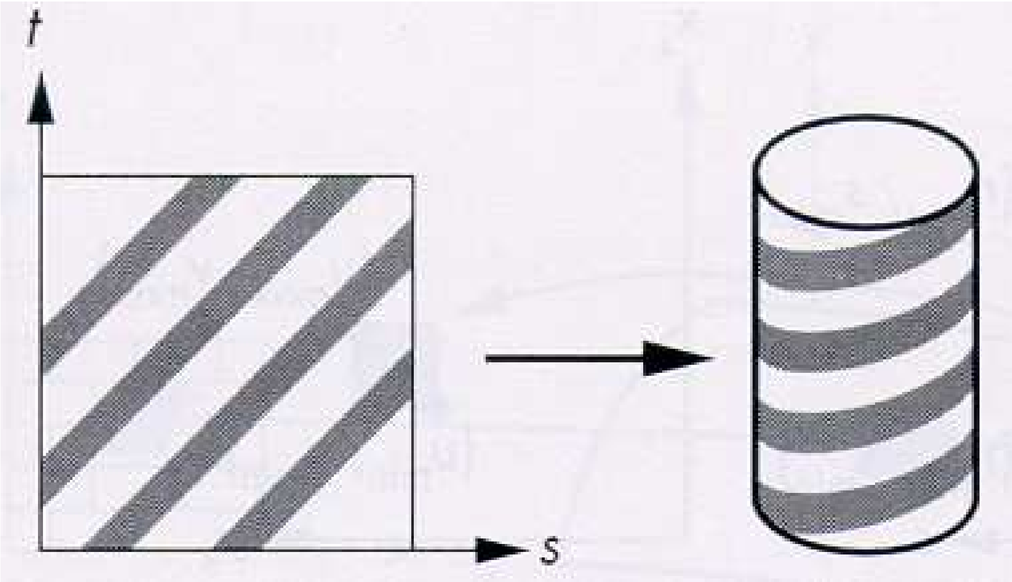
$x = rcos(2\pi u) \qquad 0 \le u \le 1$

$y = rsin(2\pi u)$

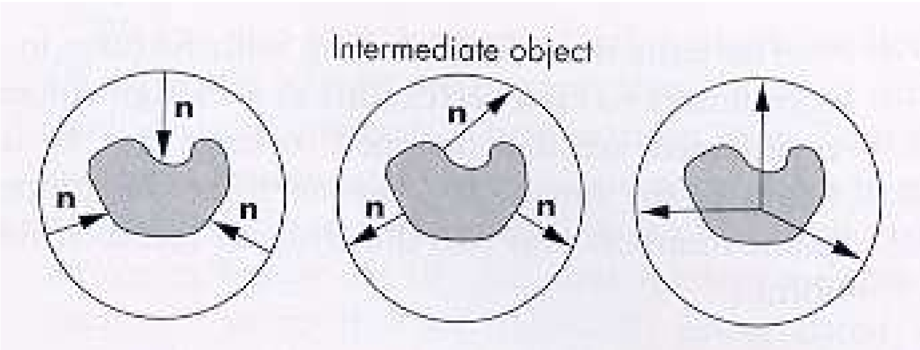
$z = v/h \qquad 0 \le v \le 1$

Mapping (texture -> cylinder)

$s = u, t = v$



- Examples (step 2)



- **Bump maps**

  - The *normal* at a point on the surface characterizes the shape of the surface at this point

  - Idea: we can create a surface with small variations by *purturbing* the normal at each point on the surface

- **Environmental maps**

  - Highly reflective surfaces "mirror" the environment

  - Ray tracing can be used to model this effect but it is too time consuming

  - Steps using environmental maps

    1. Obtain the image of the environment on an intermediate projection surface (e.g, sphere, cylinder)

    (the center of projection is located at the center of the reflective object, but the projections are computed with the object removed from the scene)

    2. Treat the environment image as a texture map !!