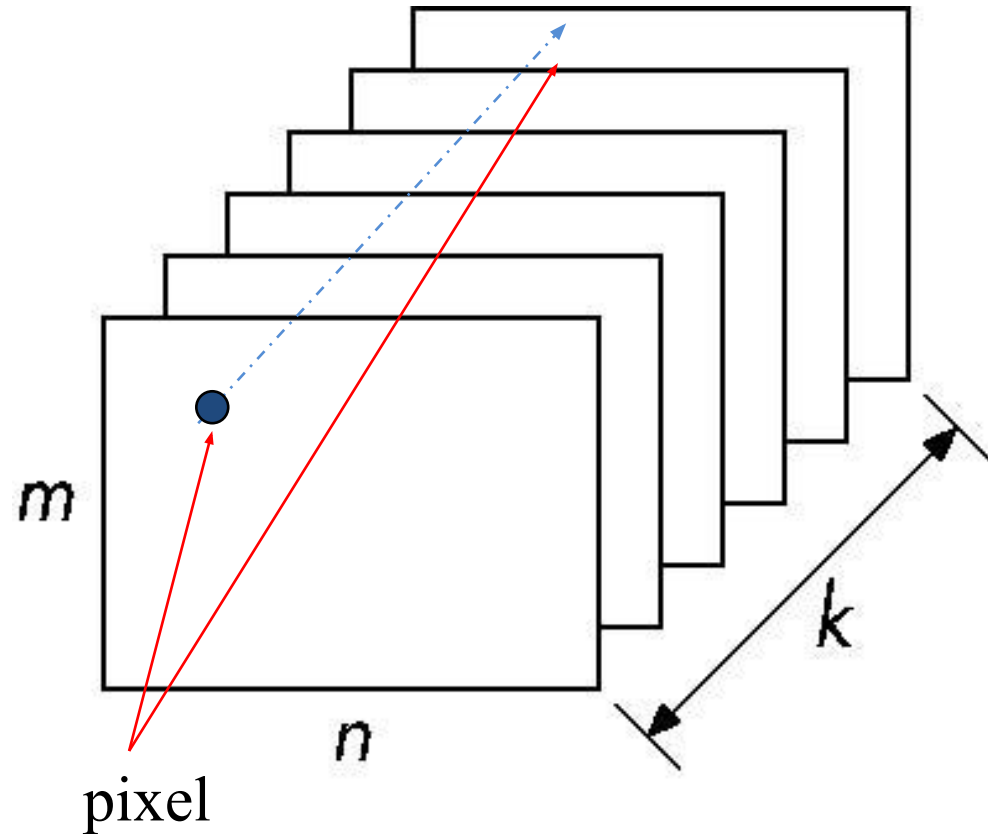# Outline

- Buffers and Digital Images
- Sampling and Aliasing
- Mapping Methods
  - Texture mapping
  - Environment mapping
  - Bump mapping

Outline

- **Buffers and Digital Images**
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Buffer

- Buffers
  - Color buffers (front and back)
  - Depth buffer
  - Others
- A (2D) buffer is a block of memory with:

  - Spatial resolution (n x m)

  - Depth (k – the number of bits per pixel) elements
- These are generally on GPU memory

m

n

k

pixel

WebGL Framebuffer

- Framebuffer is a <u>collection</u> of buffers

- Even in a simple case, total depth goes over 100 bits/pixel
  - Front and back buffers: (RGBA and 8 bits per component) 32 bits
  - Depth buffer (24 or 32 bits)

Stencil buffer
Depth buffer
Back buffer
Front buffer

m

n
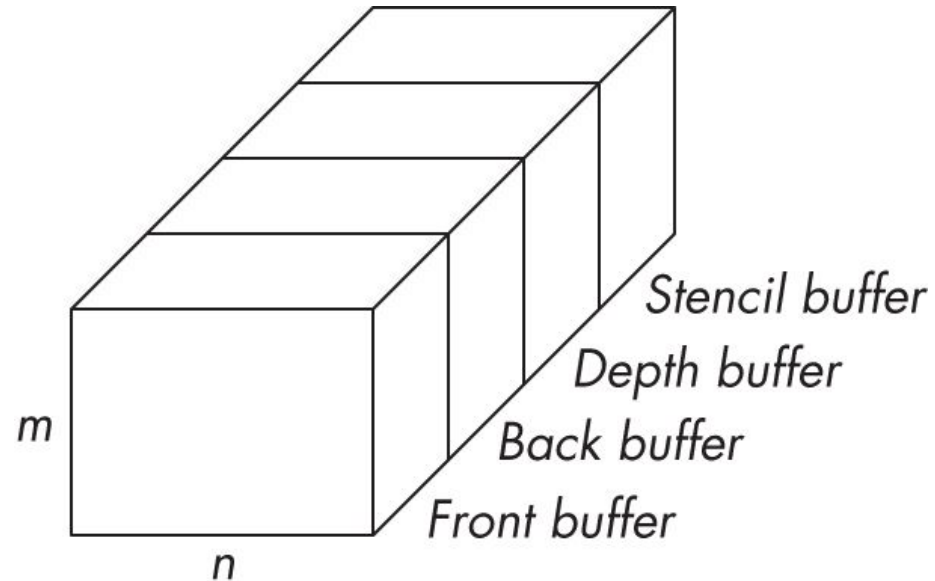
(Digital) Images

- 2D array of pixels (an array of values)
- GIF, JPEG, PNG keep data differently mainly to reduce size
- WebGL doesn't have functions to directly read these formats or to convert

Outline

- Buffers and Digital Images
- **Sampling and Aliasing**
- Mapping Methods
  - Texture mapping
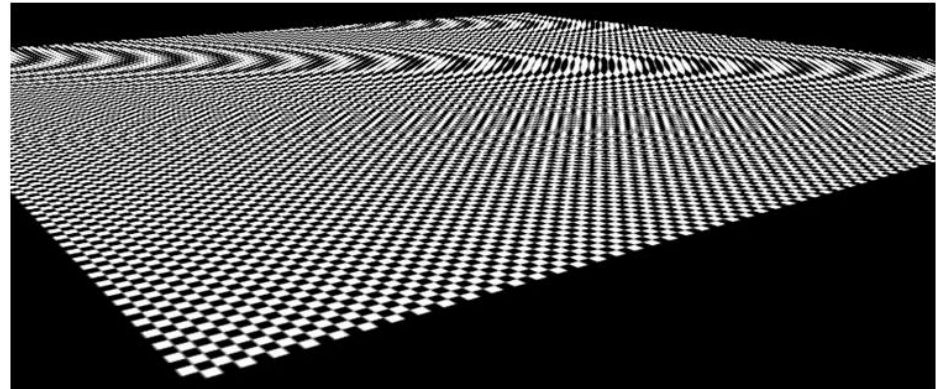 - Environment mapping
  - Bump mapping

Shannon's Theorem

The sampling rate must be at least twice the frequency of the signal or *aliasing* occurs (twice the frequency of the highest frequency component), Nyquist rate.
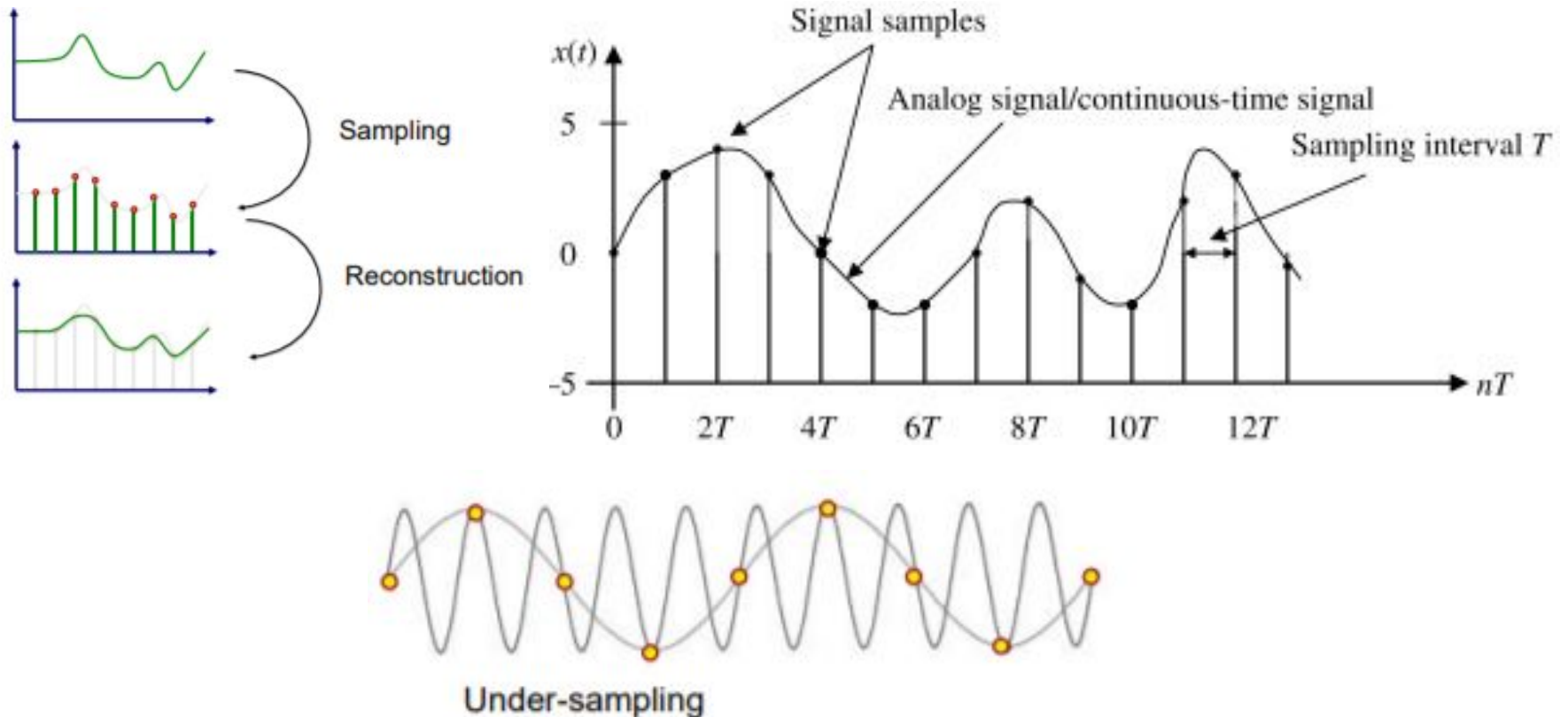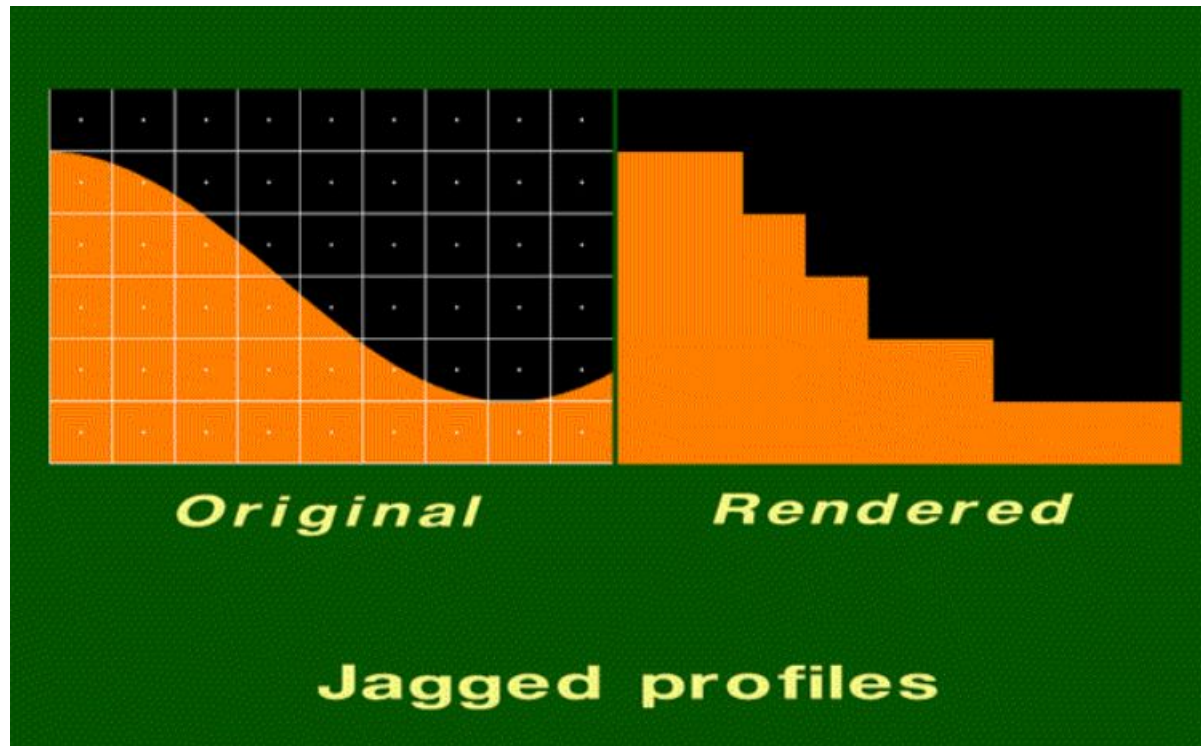
Sampling and Aliasing

- **Aliasing** is an effect that causes different signals to become indistinguishable (or aliases of one another) when **sampled**

Sampling and Aliasing

Original   Rendered

Jagged profiles

Antialiasing

- Two major categories of antialiasing:
 - prefiltering
  - postfiltering

Outline

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Mapping Methods

Mapping Methods

- **Texture Mapping**
  - Uses images to fill inside of polygons
- **Bump mapping**
  - Emulates altering normal vectors during the rendering process
  - Creates the illusion of small variations (bumps, dents) on surface
- **Environment (Reflection) Mapping**
  - Uses a picture of the environment for texture maps
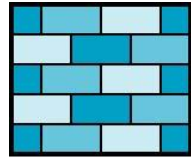 - Allows simulation of highly reflective surfaces
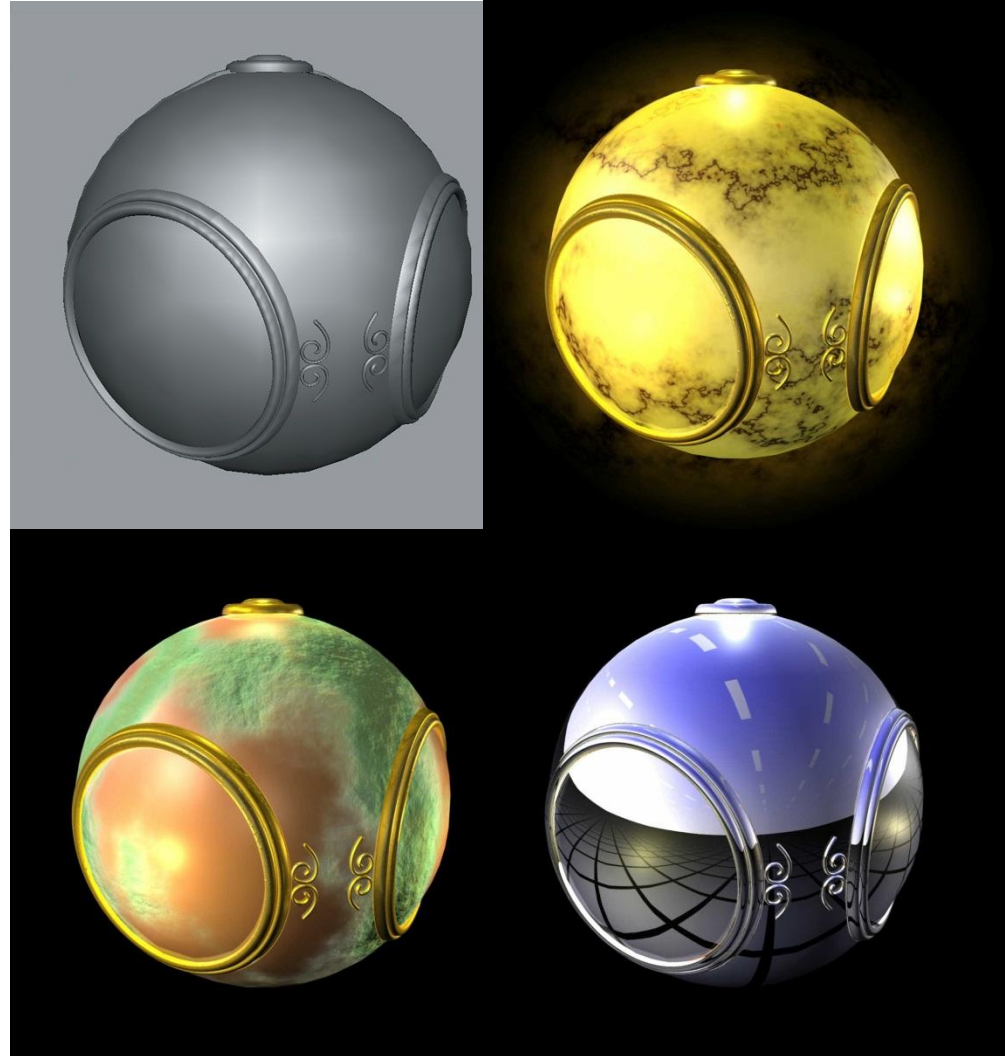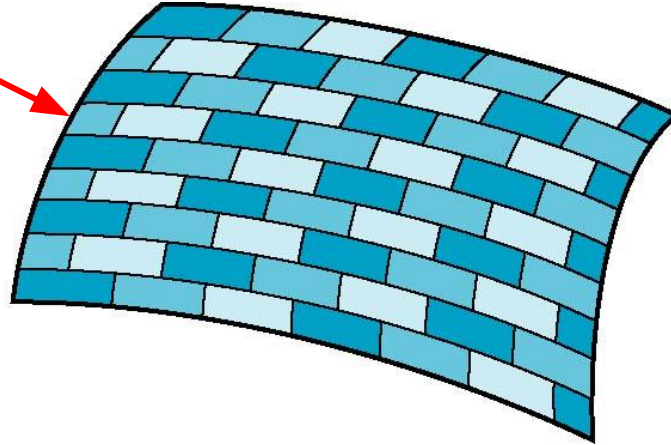
Texture Mapping

Texture Mapping

- 2D texture is an image

- not pixels but **texels**

- where and what are **texture coordinates**

- A **texture map** associates a texel with a point on a geometric object surface

# Is it simple?

2D image

3D surface

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
  - Where the mapping takes place
- Window Coordinates
  - Where the final image is really produced

Texture Mapping

parametric coordinates

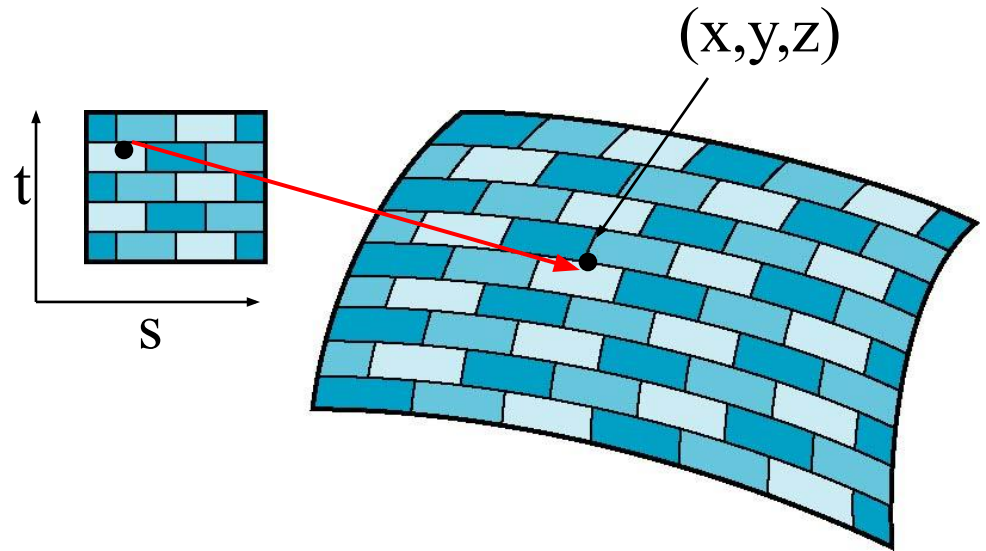texture coordinates

world coordinates

window coordinates
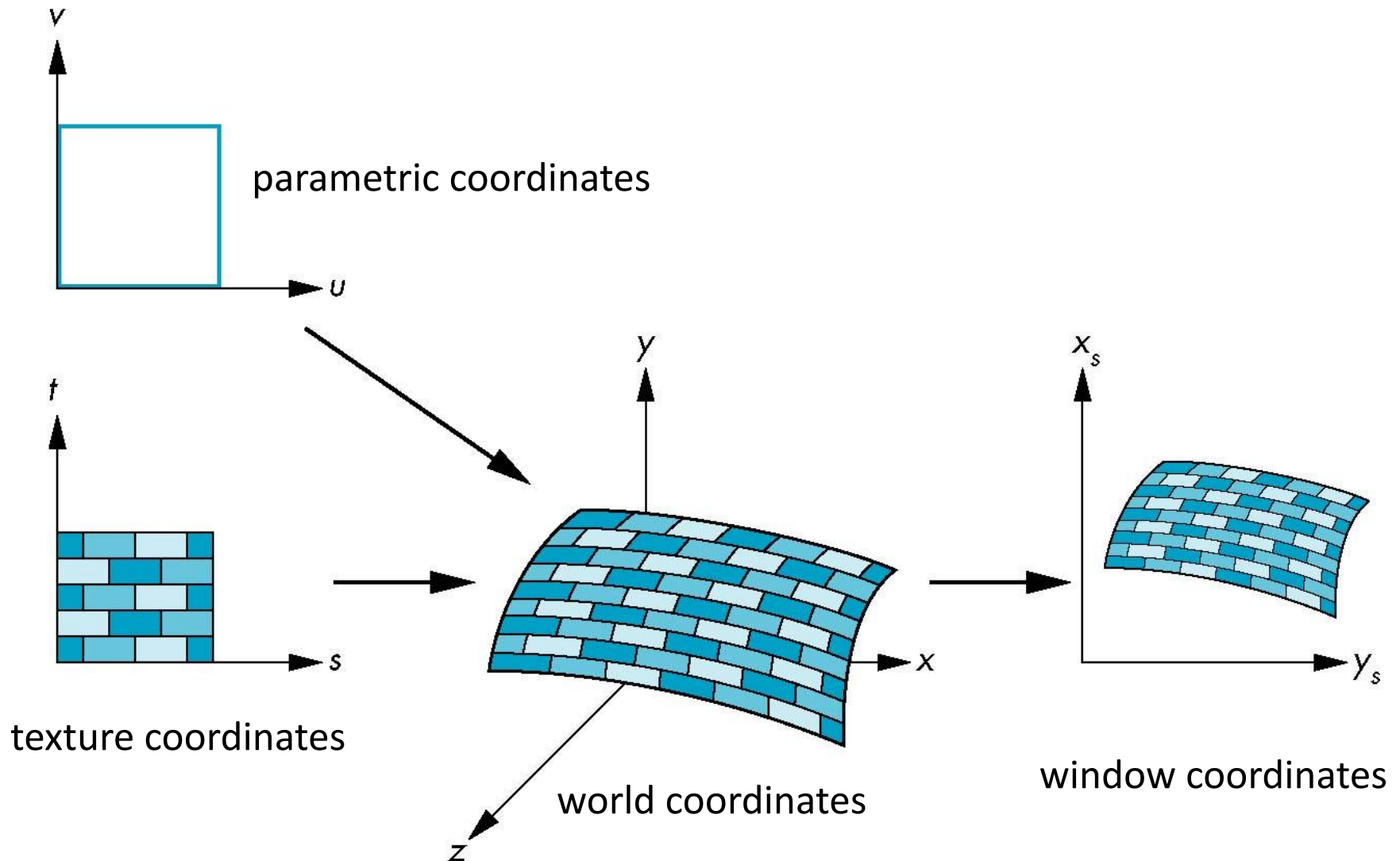
Mapping Functions

- How to find the maps?
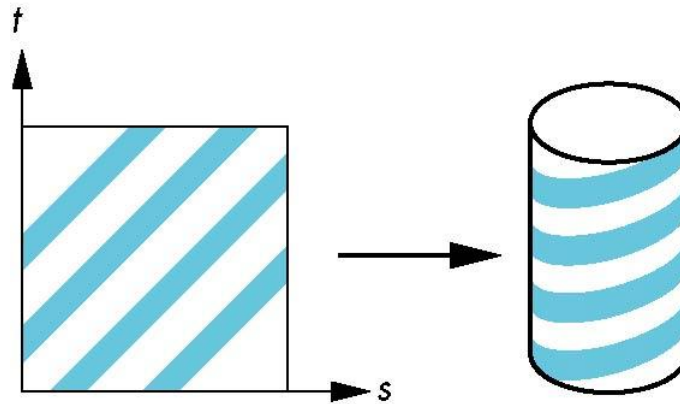- Mapping from texture coordinates to a point a surface need three functions:
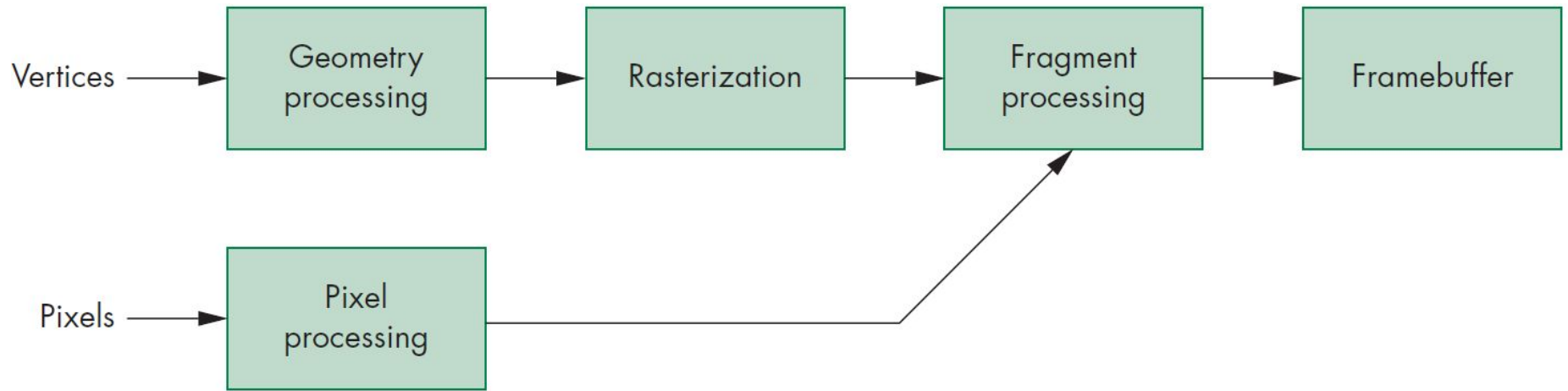
$$x = x(s,t)$$
$$y = y(s,t)$$
$$z = z(s,t)$$

(x,y,z)

Two-Step Mapping

* Map the texture to a simple intermediate surface (map to cylinder, sphere, or box)
* Map this surface to the actual surface

Texture Mapping in WebGL

Vertices → [Geometry processing] → [Rasterization] → [Fragment processing] → [Framebuffer]

Pixels → [Pixel processing] → [Fragment processing]

Environment Mapping

- Creates the appearance of highly reflective surfaces without global calculations

Bump Mapping