Image Compositing & Morphing

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Image Processing

• Pixel operations
  o Add random noise
  o Add luminance
  o Add contrast
  o Add saturation
• Filtering
  o Blur
  o Detect edges
  o Sharpen
  o Emboss
  o Median
• Quantization
  o Uniform Quantization
  o Floyd-Steinberg dither
• Warping
  o Scale
  o Rotate
  o Warp
• Combining
  o Composite
  o Morph

Image Compositing

• Combine images
  o Separate image into "elements"
  o Generate independently
  o Composite together
• Applications
  o Cel animation
  o Chroma-keying
  o Blue-screen matting

Cel Animation

• Classical animation technique (Disney)
• Superimposition of different layers on translucent films

Blue-Screen Matting

• Composite foreground and background images
  o Create background image
  o Create foreground image with blue background
  o Insert non-blue foreground pixels into background

Problem: no partial coverage!
Alpha Channel

- Encodes pixel coverage information
  - $\alpha = 0$: no coverage (or transparent)
  - $\alpha = 1$: full coverage (or opaque)
  - $0 < \alpha < 1$: partial coverage (or semi-transparent)

- Example: $\alpha = 0.3$

Semi-Transparent Objects

- Suppose we put A over B over background G
  - How much of B is blocked by A?
    - $\alpha_A$
  - How much of B shows through A
    - $(1-\alpha_A)$
  - How much of G shows through both A and B?
    - $(1-\alpha_A)(1-\alpha_B)$

Opaque Objects

- How do we combine 2 partially covered pixels?
  - 3 possible colors (0, A, B)
  - 4 regions (0, A, B, AB)

Composition Algebra

- 12 reasonable combinations

Example: C = A Over B

- Consider the areas covered:
  - $C = \alpha_A A + (1-\alpha_A) \alpha_B B$
  - $\alpha = \alpha_A + (1-\alpha_A) \alpha_B$

Example: C = A Over B

Assumption: coverages of A and B are uncorrelated for each pixel
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Cross-Dissolving

- Blend images with “over” operator
  - Alpha of bottom image is 1.0
  - Alpha of top image varies from 0.0 to 1.0
  - \( \text{blend}(i,j) = (1-t) \text{src}(i,j) + t \text{dst}(i,j) \) \( (0 \leq t \leq 1) \)

Image Morphing

- Animate transition between two images

Beier & Neeley Example

- Hard part is defining warp to intermediate images
  - Aim to align features
  - Aim to preserve shapes

Alexa
**Warping Pseudocode**

```
WarpImage(Image, L[...], L[...])
begin
    ! foreach destination pixel p do
    !     psum = (0,0)
    !     wsum = 0
    !     foreach line L[i] in destination do
    !         p[i] = p transformed by (L[i],L'[i])
    !         psum = psum + p[i] * weight[i]
    !     end
    !     wsum += weight[i]
    ! end
    ! p = psum / wsum
    Result(p) = Resample(p)
end

```

**Morphing Pseudocode**

```
GenerateAnimation(Image0, L0[...], Image1, L1[...])
begin
    ! foreach intermediate frame time t do
    !     for i = 1 to number of line pairs do
    !         L[i] = line t-th of the way from L0[i] to L1[i]
    !     end
    !     Warp0 = WarpImage(Image0, L0, L)
    !     Warp1 = WarpImage(Image1, L1, L)
    !     foreach pixel p in FinalImage do
    !         Result(p) = (1-t) Warp0 + t Warp1
    !     end
end
```

**More Advanced Image Morphing**

- Automatic methods to avoid shape deformations during interpolating warp
- "As rigid as possible" shape interpolation
Summary

• Image compositing
  o Alpha channel
  o Porter-Duff compositing algebra
• Image morphing
  o Warping
  o Compositing

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Next Time: 3D Modeling