Introducing Assignment 1: Image Processing - Morphing

COS 426: Computer Graphics (Spring 2019)
Morph

• Basic concepts
  – transform the background image to the foreground image
  – alpha = 0: show background
  – alpha = 1: show foreground
  – alpha is the blending factor / timestamp

• General approach
  – specify correspondences (morphLines.html)
  – create an intermediate image with interpolated correspondences (alpha)
  – warp the background image to the intermediate image
  – warp the foreground image to the intermediate image
  – blend using alpha
Interpolate Morph Lines

\[
\text{Interpolated Correspondances:} \quad \text{current\_line}[i] = (1 - \alpha) \times \text{background\_lines}[i] + \alpha \times \text{foreground\_lines}[i]
\]
Since many morph lines, we do a weighted average of computed $X'(s)$ for $X$.

**Projection of PX onto PQ**

scalar

\[ u = \frac{(X - P) \cdot (Q - P)}{||Q - P||^2} = \frac{(X - P) \cdot (Q - P)}{||Q - P||} \times \frac{1}{||Q - P||} \]

unit vector

\[ v = \frac{(X - P) \cdot \text{Perpendicular}(Q - P)}{||Q - P||} \]

unit vector

\[ X' = P' + u \cdot (Q' - P') + \frac{v \cdot \text{Perpendicular}(Q' - P')}{||Q' - P'||} \]

**dist = shortest distance from $X$ to PQ**

- $0 \leq u \leq 1$: dist = $||v||$
- $u < 0$: dist = $||X - P||$
- $u > 1$: dist = $||X - Q||$

**weight =**

\[ \frac{\text{length}_P^b}{a + \text{dist}} \]

- we use $p = 0.5$, $a = 0.01$, $b = 2$
**Warp Image**

Inverse Mapping

Let S be the projection point of X onto PQ.

\[ u = \text{fraction of } SP\text{'s signed length over } PQ\text{'s absolute length} \]

\[ v = X\text{'s signed distance to } PQ, \text{ or to say, signed length of } SX \]

Warped background or foreground (currently black)

Pixel source (background or foreground)
For each pixel $X$ in the destination

$DSUM = (0, 0)$

$weightsum = 0$

For each line $P_i Q_i$

- calculate $u, v$ based on $P_i Q_i$
- calculate $X'_i$ based on $u, v$ and $P_i Q_i$
- calculate displacement $D_i = X'_i - X_i$ for this line
- $dist =$ shortest distance from $X$ to $P_i Q_i$
- $weight = (length^p / (a + dist))^b$
- $DSUM += D_i * weight$
- $weightsum += weight$

$X' = X + DSUM / weightsum$

$destinationImage(X) = sourceImage(X')$
Blending

alpha = 0.5 (also the blending factor)
Blending

alpha = 0.5 (also the blending factor)

Background Image

Foreground Image
Morph

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
end