COS426 Precept3

Image Processing

Presented by: Linguang Zhang
Edge Filter vs Sharpen Filter

\[
\begin{array}{ccc}
-1 & -1 & -1 \\
-1 & 8 & -1 \\
-1 & -1 & -1 \\
\end{array}
\]  

\[
\begin{array}{ccc}
-1 & -1 & -1 \\
-1 & 9 & -1 \\
-1 & -1 & -1 \\
\end{array}
\]

Edge Filter  
Sharpen Filter

\[\text{Convolution}(\text{Image}, \text{Sharpen Filter}) = \text{Convolution}(\text{Image}, \text{Edge Filter}) + \text{Image}\]
Histogram Matching / Equalization

pdf

cdf
Histogram Matching / Equalization
Histogram Matching / Equalization

Matching

\[ x' = \arg \min_i |CDF(x) - CDF_{ref}(i)| \]

Convert back to [0, 1]: \[ x' = \frac{x'}{L-1} \]
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
Blending

alpha = 0.5 (also the blending factor)
Blending

alpha = 0.5 (also the blending factor)
Interpolate Morph Lines

current_line[i] = (1 – alpha) * background_lines[i] + alpha * foreground_lines[i]
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
  Warp₀₀ = WarpImage(Image₀₀, L₀, L)
  Warp₁₁ = WarpImage(Image₁₁, L₁, L)
  foreach pixel p in FinalImage do
    Result(p) = (1-t) Warp₀₀ + t Warp₁₁
  end
end
Warp Image

Q - P = (x, y)
Perpendicular(Q - P) = (y, -x)

Warped background or foreground (currently black)

Pixel source (background or foreground)
Warp Image

- \( u = \frac{(X-P) \cdot (Q-P)}{|Q-P|^2} \)
- \( v = \frac{(X-P) \cdot \text{Perpendicular}(Q-P)}{|Q-P|} \) (unit vector)
- \( X' = P' + u \cdot (Q' - P') + \frac{v \cdot \text{Perpendicular}(Q' - P')}{|Q' - P'|} \)
- \( \text{dist} = \text{shortest distance from } X \text{ to } PQ \)
  - \( 0 \leq u \leq 1: \text{dist} = |v| \)
  - \( u < 0: \text{dist} = ||X - P|| \)
  - \( u > 1: \text{dist} = ||X - Q|| \)
- \( \text{weight} = \left( \frac{\text{length}^p}{a + \text{dist}} \right)^b \)
  - we use \( p = 0.5, a = 0.01, b = 2 \)
Warp Image

For each pixel $X$ in the destination

$DSUM = (0,0)$

$weightsum = 0$

For each line $P_iQ_i$

- calculate $u,v$ based on $P_iQ_i$
- 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 $P_iQ_i$
- $weight = (\text{length}^p / (a + dist))^b$
- $DSUM += D_i \ast weight$
- $weightsum += weight$

$X' = X + DSUM / weightsum$

destinationImage$(X) = sourceImage(X')$
Q&A