

COS426 Precept3

Image Processing

Presented by: Linguang Zhang

Edge Filter vs Sharpen Filter

-1	-1	-1
-1	8	-1
-1	-1	-1

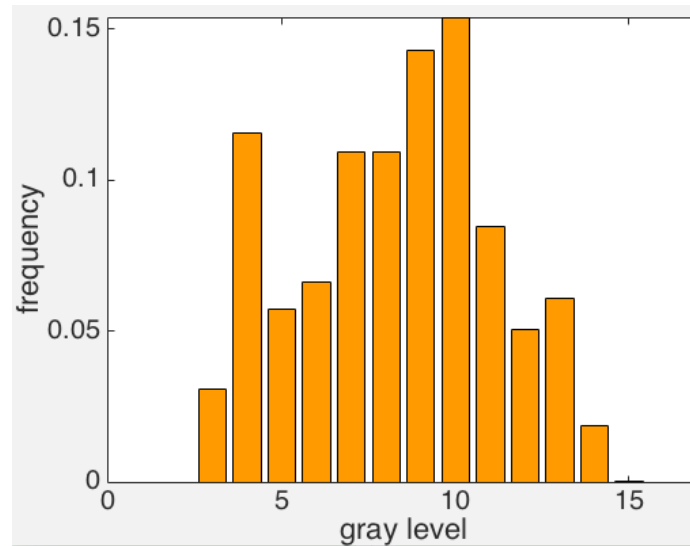
Edge Filter

-1	-1	-1
-1	9	-1
-1	-1	-1

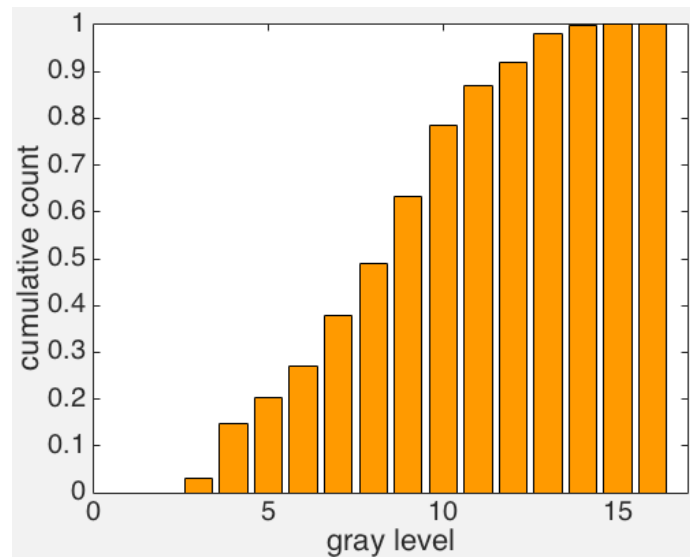
Sharpen Filter

$$\text{Convolution}(\text{Image}, \text{Sharpen Filter}) = \text{Convolution}(\text{Image}, \text{Edge Filter}) + \text{Image}$$

Histogram Matching / Equalization

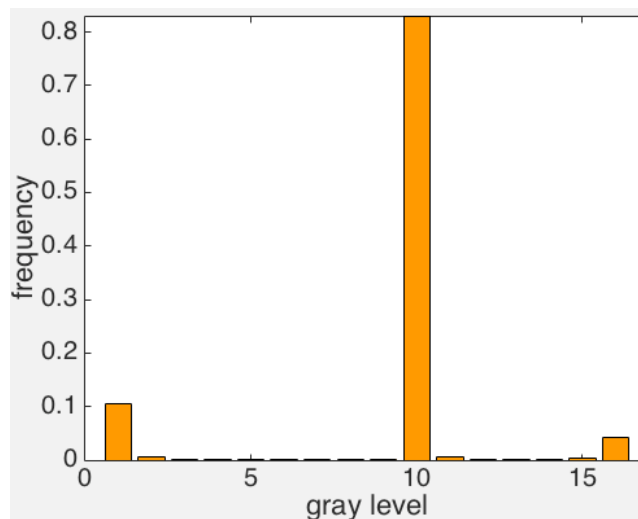


pdf

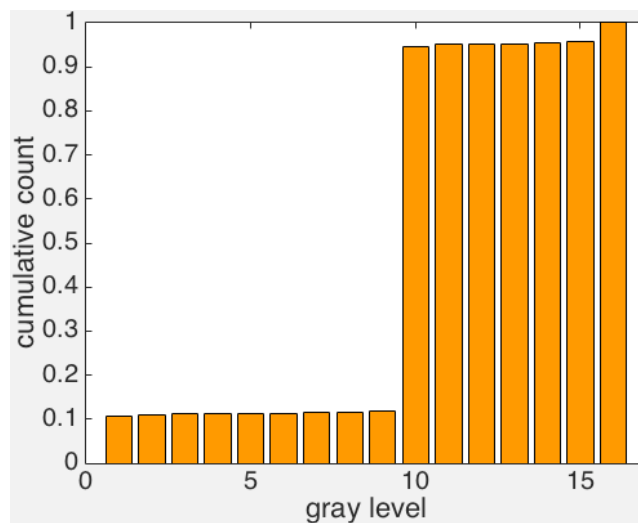


cdf

Histogram Matching / Equalization

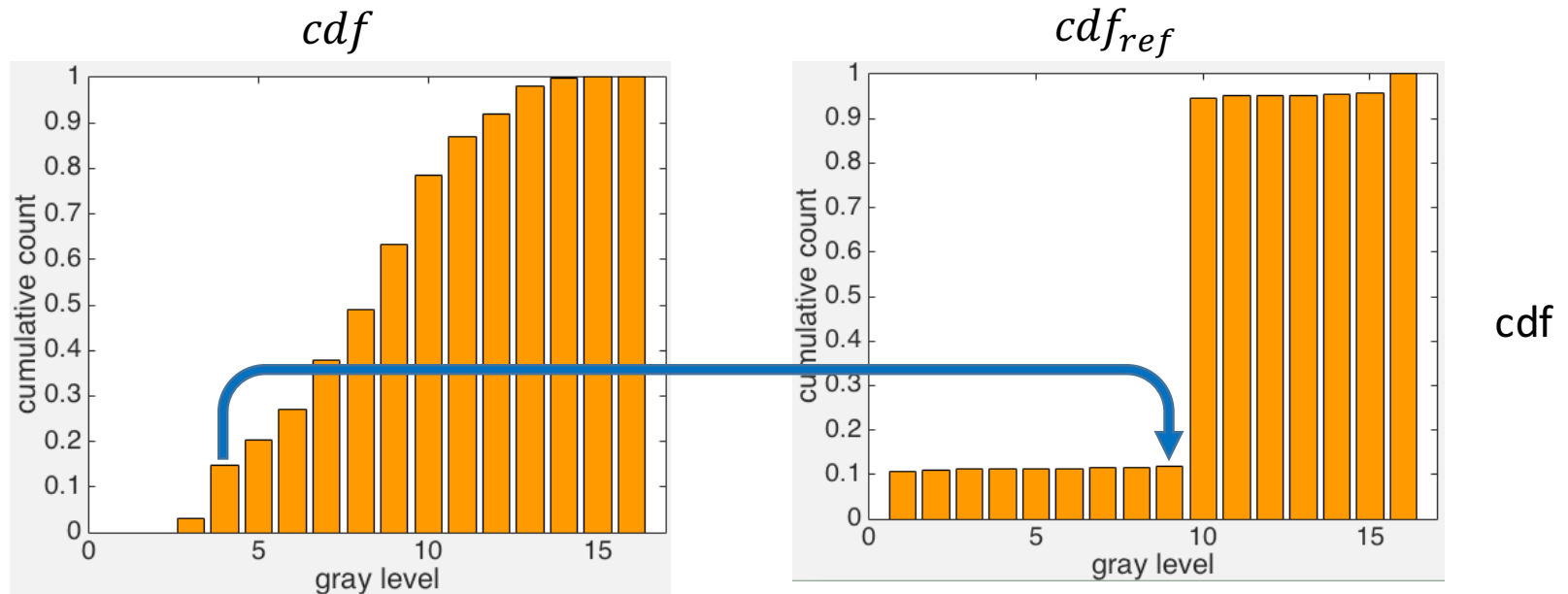


pdf



cdf

Histogram Matching / Equalization



Matching

$$x' = \underset{i}{\operatorname{argmin}} |cdf(x) - cdf_{ref}(i)|$$

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

Morph

- Basic concepts
 - transform the background image to the foreground image
 - $\alpha = 0$: show background
 - $\alpha = 1$: show foreground
 - α is the blending factor / timestamp
- General approach
 - specify correspondences ([morphLines.html](#))
 - create an intermediate image with interpolated correspondences (α)
 - warp the background image to the intermediate image
 - warp the foreground image to the intermediate image
 - blend using α

Blending

$\alpha = 0.5$ (also the blending factor)



Background Image

WarpImage()



+



WarpImage()



Foreground Image

Blending

$\alpha = 0.5$ (also the blending factor)

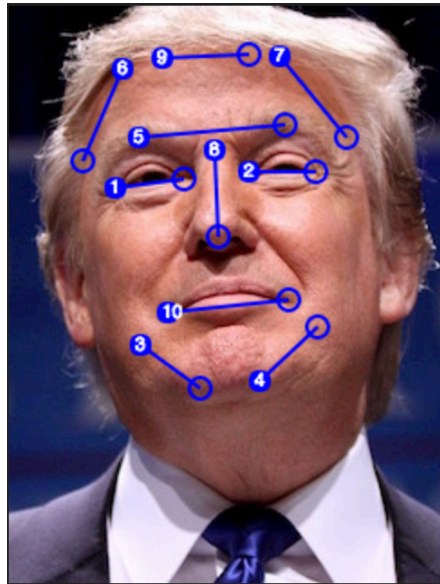


Background Image

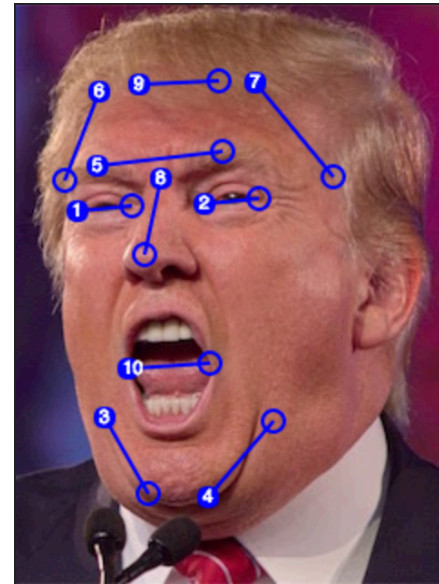


Foreground Image

Interpolate Morph Lines



Background Image



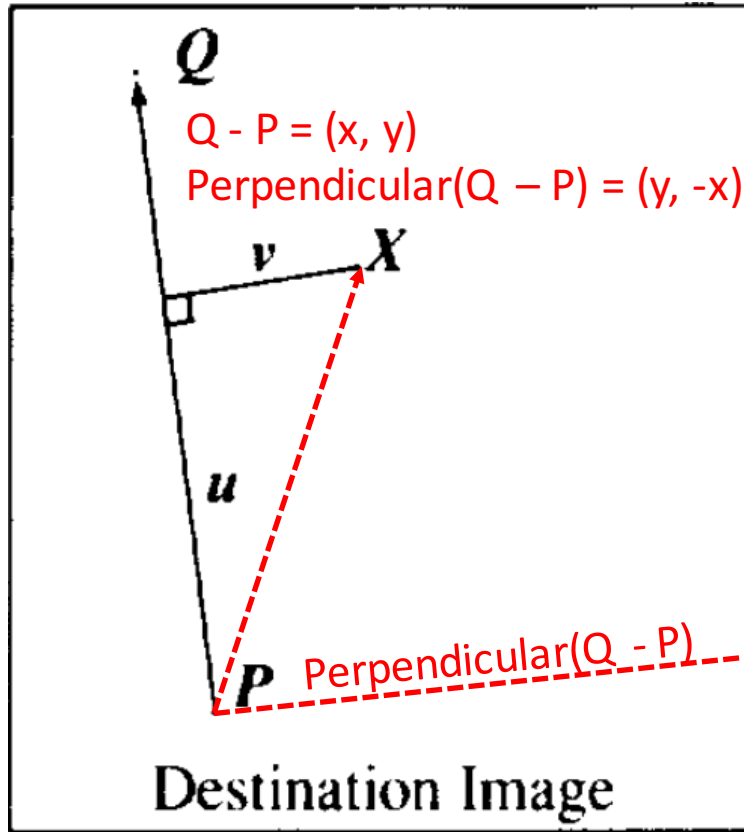
Foreground Image

$$\text{current_line}[i] = (1 - \alpha) * \text{background_lines}[i] + \alpha * \text{foreground_lines}[i]$$

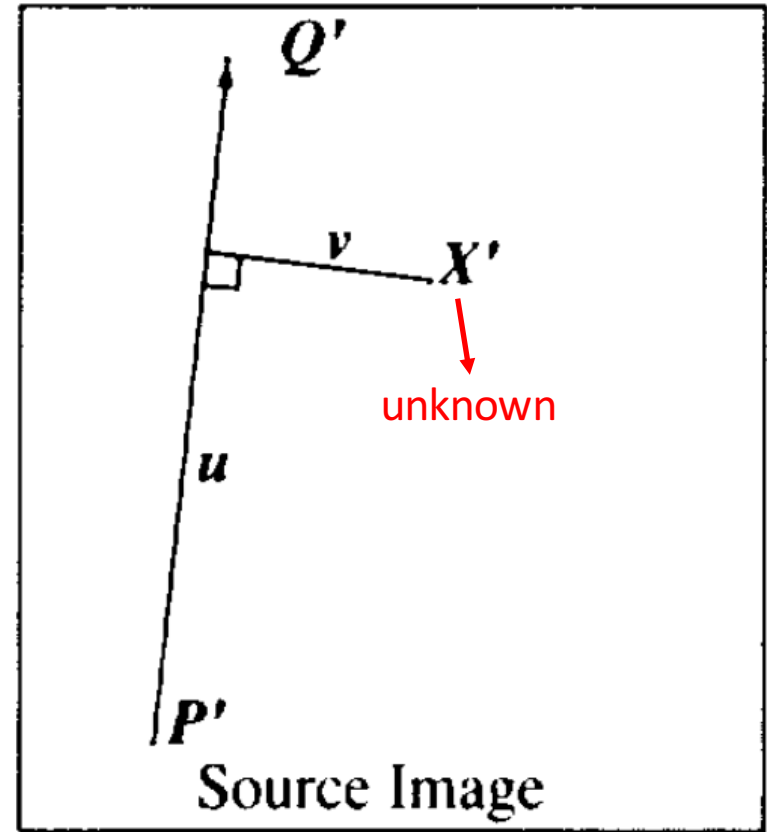
Morph

```
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
    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
```

Warp Image



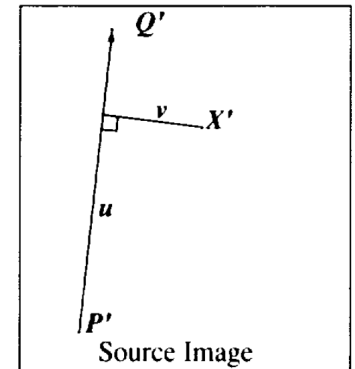
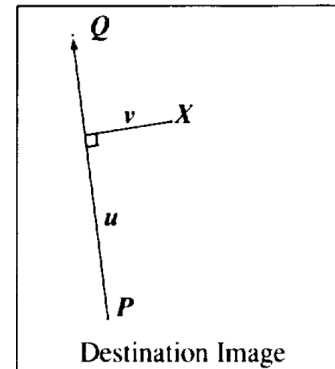
Warped background or foreground (currently black)



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
- $X' = P' + u \cdot (Q' - P') + \frac{v \cdot \text{Perpendicular}(Q' - P')}{||Q' - P'||}$
- $dist = \text{shortest distance from } X \text{ to } PQ$
 - $0 \leq u \leq 1$: $dist = |v|$
 - $u < 0$: $dist = ||X - P||$
 - $u > 1$: $dist = ||X - Q||$
- $weight = \left(\frac{length^p}{a+dist}\right)^b$
 - 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 $P_i Q_i$

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 $P_i Q_i$

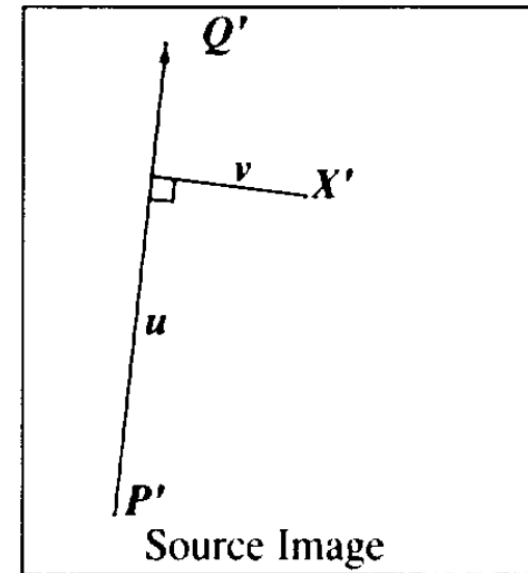
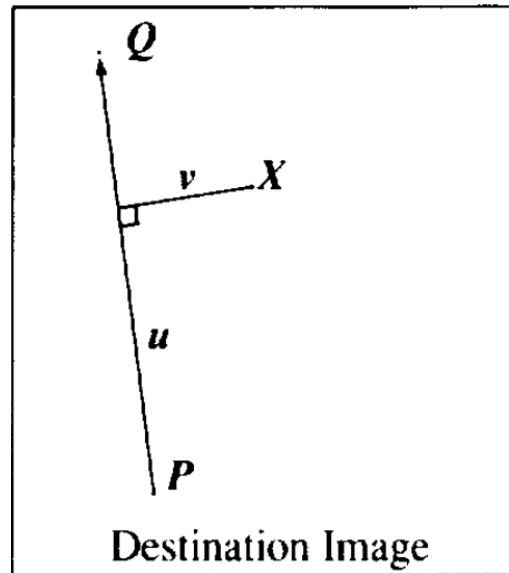
$weight = (length^P / (a + dist))^b$

$DSUM += D_i * weight$

$weightsum += weight$

$X' = X + DSUM / weightsum$

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



Q&A