Tai Duc Nguyen - CS 435 - HW3 - 05/04/19

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Assignment 3 Theory

Q1

Below are two images, the one we're copying to and the one we're copying from.

$$F = \begin{bmatrix} 1 & 0 & 2 & 2 & 1 \\ 4 & 3 & 5 & 1 & 2 \\ 4 & 4 & 4 & 4 & 6 \\ 4 & 5 & 2 & 0 & 2 \\ 2 & 3 & 3 & 0 & 3 \\ 1 & 0 & 0 & 5 & 2 \end{bmatrix}$$

$$T = \begin{bmatrix} 4 & 5 & 6 & 1 & 2 \\ 1 & 2 & 5 & 3 & 3 \\ 3 & 3 & 3 & 6 & 4 \\ 2 & 4 & 2 & 5 & 1 \\ 4 & 5 & 3 & 1 & 0 \\ 3 & 3 & 1 & 1 & 0 \end{bmatrix}$$

Q1a

Find the equation for J using the values found in the matrices above

Answer:

$J = \sum_{i=2}^{4} \sum_{j=2}^{4} I_{i,j}$

$J = I_{2,2} + I_{2,3} + I_{2,4} + I_{3,2} + I_{3,3} + I_{3,4} + I_{4,2} + I_{4,3} + I_{4,4}$
$= ((T_{2,2} - T_{1,2}) - (F_{2,2} - F_{1,2}))^2 + ((T_{2,3} - T_{1,3}) - (F_{2,3} - F_{1,3}))^2 + ((T_{2,4} - T_{1,4}) - (F_{2,4} - F_{1,4}))^2 + ((T_{3,2} - T_{2,2}) - (F_{3,2} - F_{2,2}))^2 + ((T_{3,3} - T_{2,3}) - (F_{3,3} - F_{2,3}))^2 + ((T_{3,4} - T_{2,4}) - (F_{3,4} - F_{2,4}))^2 + ((T_{4,2} - T_{3,2}) - (F_{4,2} - F_{3,2}))^2 + ((T_{4,3} - T_{3,3}) - (F_{4,3} - F_{3,3}))^2 + ((T_{4,4} - T_{3,4}) - (F_{4,4} - F_{3,4}))^2$
$= 4 + 1 + 4 + 0 + 0 + 9 + 9 + 1 + 25 = 53$

Q1b

Next compute the partial derivative of this cost function with regards to our knowns

Answer:

$T_{2,2} = a; T_{2,3} = b; T_{3,2} = c; T_{3,3} = d$

$J = ((a - 1) + 1)^2 + ((b - 3) - 0)^2 + 1 + ((c - a) - 2)^2 + ((d - b) - 0)^2 + 9 + ((3 - c) + 4)^2 + ((6 - d) - 0)^2 + 25$
$= 2a^2 + 4a + 2b^2 - 6b + 2c^2 - 18c + 2d^2 - 12d - 2ac - 2db + C$

$\frac{\delta J}{\delta a} = 4a + 4 - 2c$

$\frac{\delta J}{\delta b} = 4b - 6 - 2d$

$\frac{\delta J}{\delta c} = 4c - 18 - 2a$

$\frac{\delta J}{\delta d} = 4d - 12 - 2b$

Q1c

Finally, to minimize the partials, set them equal to zero and arrange in a matrix format such that Af = b

Answer:

$Af = b$

$$A = \begin{bmatrix} 4 & 0 & -2 & 0 \\ 0 & 4 & 0 & -2 \\ -2 & 0 & 4 & 0 \\ 0 & -2 & 0 & 4 \end{bmatrix}$$

$$b = \begin{bmatrix} -4 \\ 6 \\ 18 \\ 12 \end{bmatrix}$$

Q1d

Solve for f using Matlab

Answer:

$$f = A^{-1} * b$$

$$f = \begin{bmatrix} 1.6667 \\ 4.0000 \\ 5.3333 \\ 5.0000 \end{bmatrix}$$

Q2

If the image below is the gradient of an image:

$$A = \begin{bmatrix} 2 & 3 & 4 & 5 & 1 \\ 1 & 0 & 2 & 2 & 1 \\ 4 & 3 & 5 & 1 & 2 \\ 4 & 4 & 4 & 4 & 6 \\ 4 & 5 & 2 & 0 & 2 \\ 2 & 3 & 3 & 0 & 3 \end{bmatrix}$$

Q2a

Construct the optimal seam matrix if we assume vertical seams

Answer:

$$S = \begin{bmatrix} 2 & 3 & 4 & 5 & 1 \\ 3 & 2 & 5 & 3 & 2 \\ 6 & 5 & 7 & 3 & 4 \\ 9 & 9 & 7 & 7 & 9 \\ 13 & 12 & 9 & 7 & 9 \\ 14 & 12 & 10 & 7 & 10 \end{bmatrix}$$

Q2b

What is the optimal seam?

Answer:

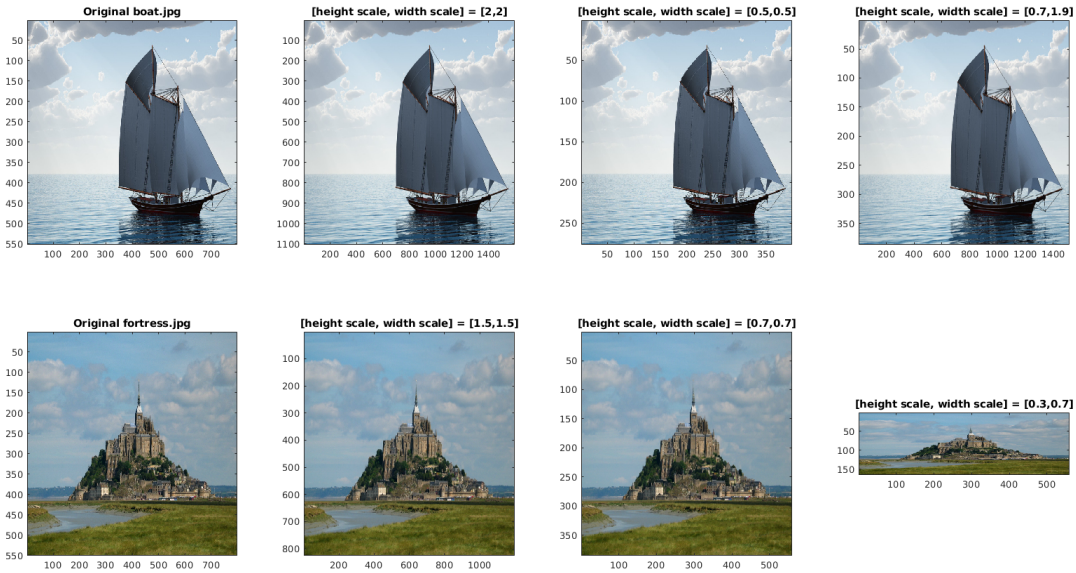
$$S = \begin{bmatrix} 2 & 3 & 4 & 5 & (1) \\ 3 & 2 & 5 & 3 & (2) \\ 6 & 5 & 7 & (3) & 4 \\ 9 & 9 & 7 & (7) & 9 \\ 13 & 12 & 9 & (7) & 9 \\ 14 & 12 & 10 & (7) & 10 \end{bmatrix}$$

Assignment 3 Theory

Part 1: Crop and Rescale

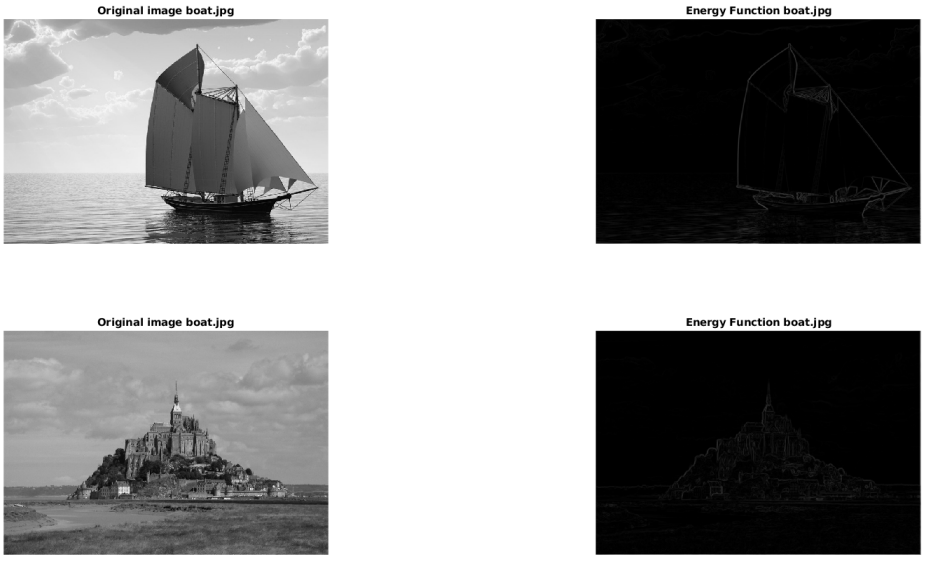
Algorithm is written after Richard Alan Peters' II digital image processing slides on interpolation

https://ia902707.us.archive.org/23/items/Lectures_on_Image_Processing/EECE_4353_15_Resampling.pdf

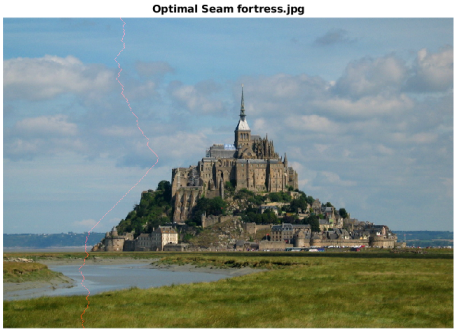


Part 2: Energy Function

NxN smoothing kernel N=5 sigma=1



Part 3: Optimal Seam



Part 4: Seam Carving

See video attached! boat.avi and fortress.avi