COURSE: DIGITAL IMAGE ANALYSIS (COL 783)

ASSIGNMENT -3

Submitted by
Rohit Katariya -2020CSZ8844
Geetha Pavani Pappu -2020EEZ8644

COL 783: Assignment -3 Report

The Assignment is an implementation of the articles "Seam Carving for Content-Aware Image Resizing" and "Fast Seam Carving Using Gaussian Pyramid".

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INTRODUCTION:

This Assignment we are using seam carving method to resize the image. Since scaling is not considering the image content, it applies uniformly all over the image. This makes scaling an inefficient method. Cropping on the other end considers the image content but it can only be applied on the periphery of the image which makes it difficult to apply where redundant part is not at the center of the image. We also apply fast seam carving method using gaussian pyramids. We also explore the object removal from the image which also works very well. Different energy functions were tried and entropy was working the best.

Orignal image -> Scaling image -> cropped image -> Seam carving

Object remoal

Original Image

Cropped Image

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Rescaled Image

Seam Carving Resize

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IMPLEMENTATION:

The assignment is implemented in python, Open CV, numpy and scipy.

Seam Carving Image scale down by m rows, n columns

Steps followed:

1. Input m, n

2. Converting to grayscale

3. Apply energy function

4. Find seams with dynamic programming in both horizontal and vertical direction

5. Select optimum minimum energy seams from both directions

6. Remove minimum energy seams

Fast Seam Carving

1. Create different layers of Gaussian pyramids from original imput image

2. Estimate the number of seams to be removed from each layer of the pyramid

3. Consider the lowest resolution layer of Gaussian pyramid

4. Apply energy function and seam carving

5. Transform the seams got in the layer *i+1*and transfrom them to the layer *i*   and remove the transformed seams from layer *i*.

6. Apply seam carving for the remaining seams which were calculated in step 2.

7. Repeat the process to all the layers

Eg:

Lets say the image size was 100*100 and number of layers to be 3. 50 seams to be removed.

So from step 2 we need to remove [0 1 12] seams from every layer.

Energy Functions

We looked at 4 energy functions:

1) Gradient energy e1:

    i)   Consider the input image and calculate the gradients of image along x-axis and y-axis separately.

    ii) Now, calculate the magnitude of gradient using the gradients along x-axis and y-axis. i.e., the magnitude of gradient is the sum of squares of gradient along x-axis and y-axis.

2) Sobel energy:

    i)   Consider the input image and calculate the gradients of image along x-axis and y-axis separately by convolving with Sobel horizontal and vertical operators accordingly.

    ii) Now, the magnitude of gradient is computed as the sum of squares of gradient obtained by horizontal and vertical directions.

3) Entropy:

    i)   It is similar as gradient energy function but has advantage of employing entropy values to strength the gradient function.

    ii) Here we consider the energy function as the sum of entropy value and magnitude of gradients

4) HOG:

    i)   It is also similar to gradient energy function and generally considered as textural descriptors.

    ii) To estimate HOG, we initially estimate gradients in horizontal and vertical directions and convert them into polar coordinates.

    iii) Now, we divide the image into cells of size 11*11. And compute the histogram of cells with gradient values.

    iv) Now finally estimate the magnitude of gradients using the gradients of each histogram. As a result, it is termed as Histogram of Gradient (HOG) energy function.

Seam insertion

In this part, we apply seam insertion i.e. increasing the width and height of the image.

1. Suppose we are to add *m* rows and *n* columns

2. Here we start with the original image and find a sequence of seams to be removed for removing m rows and n columns.

3. Once we know the sequence of removal, we can insert seams to the original imaga at the same places where we found the lowese energy seams removed.

4. We also tried with using 50% removal twice.

Object removal

Here the aim is to remove object using seam removal.

1. To achieve this, first step is to take input from user the parts of image to be removed.

2. We set the energy of this part as minimum energy

3. Then we apply seam removal algorithm, which will choose the best horizontal or vertical seam to be removed.
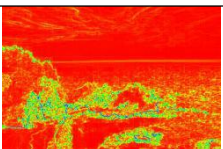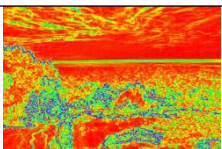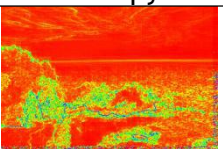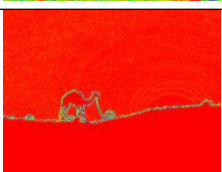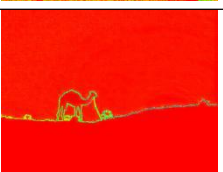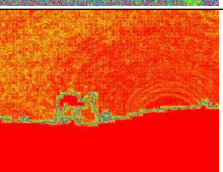
Object Preservation
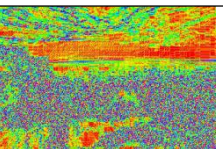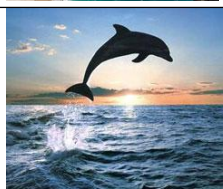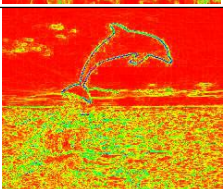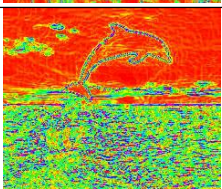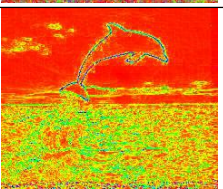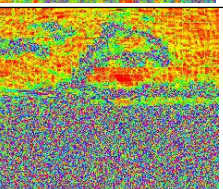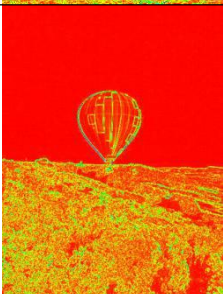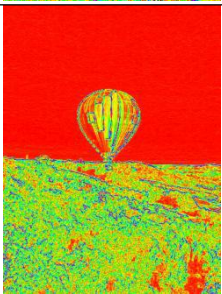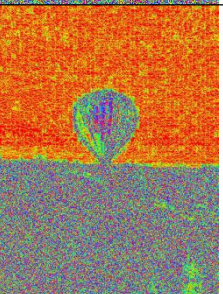
Some parts of image are too important to be modified eg. face of a person. So this part saves this part of the image from being modified in seam removal.

1. To achieve this, first step is to take input from user the parts of image to be preserved.

2. We set the energy of this part as maximum energy

3. Then we apply seam removal algorithm, which will choose the best horizontal or vertical seam to be removed.

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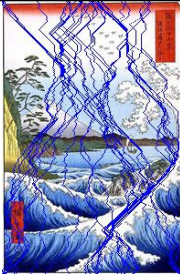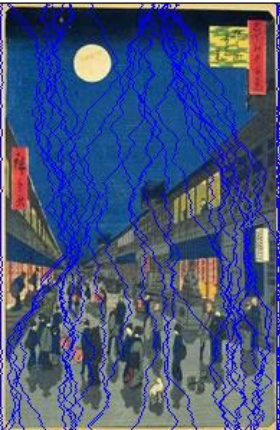
Experiments and Observations

Energy Functions with HSV colormap

Original Image	Gradient	Sobel	Entropy	HOG

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Seam removal:

Original Image	Seams image	Result

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Input	Result

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Seam Removal using Gaussian Pyramid:
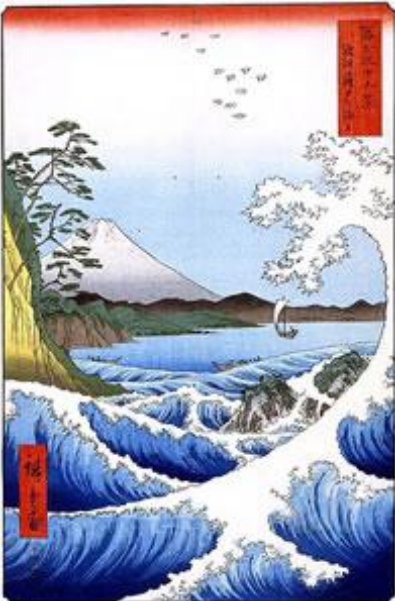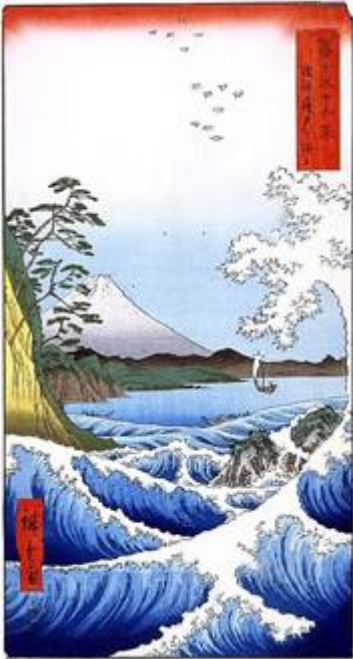
	Seam Removal using different functions (85, 89)	
Object		
Gradient Energy		
Sobel		

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Entropy		
HOG		

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Seam insertion

Input image	Insert 30 vertical seams
Insert 10 rows	Insert 30 rows remove 20 columns
Insert 40 rows 30 columns	Remove 30 rows 30 columns

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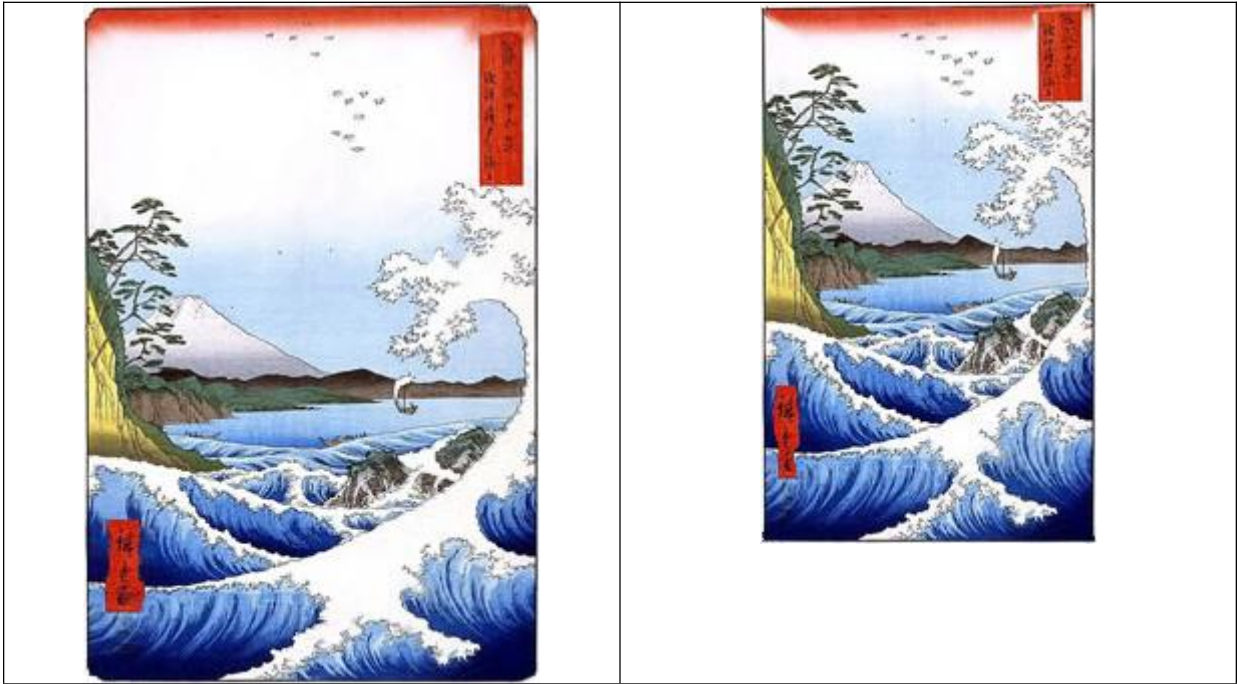
2 Stage Seam insertion

Original image	1 Shot 100 Seams insertion	2 Stage 100 seams insertion

Object Preservation

Saving the interviewee in the following image

Without Mask	With mask

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Object Removal

Original image

Mask without object preservation

Mask with object preservation

Result

Result

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Original Image

Object image

Mask image

Result

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Fast Seam Carving Computational Benefit

Table 1: Computational time comparison for seam removal with and without gaussian pyramids for Removing 60 row,70 col seams

Image		
Seam Carving	77.29 sec	82.05sec
Fast Seam Carving	9.25 sec	13.49 sec

Fast Seam Carving Computational Benefit

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Observations:

- We observed that entropy energy function performs better in seams carving.

- In object removal, the removal of object effects the nearby objects, so using Object preservation, we can reduce the distortion.

- Seam insetion is also working well and 2 stage seam insertion works better when a large number of seams are to be inserted.

- Apart from this, the removal of seam carving using gaussian pyramids reduces the computational time.